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ABSTRACT

Suggestions for providing science experiences for children in kindergarten and grades one and two are given in this first part of the Victorian Education Department (Australia) guide to the elementary school science curriculum. (See SE 012 720 and SE 012 721 for additional guides to this curriculum.) The suggestions are illustrated by brief case studies of successful teaching episodes, particularly where the activities have provided material for written expression, mathematics, and social studies as well as for science. In all cases the emphasis is on direct student experimentation and observation, with minimal teacher direction. Many possible activities are given for introducing "discrimination and classification," and "interactions and change" are suggested using living and non-living materials as examples in both cases. An appendix contains hints on collecting, maintaining, and using living organisms in the classroom. A second appendix provides ideas for developing children's awareness of time. (AL)

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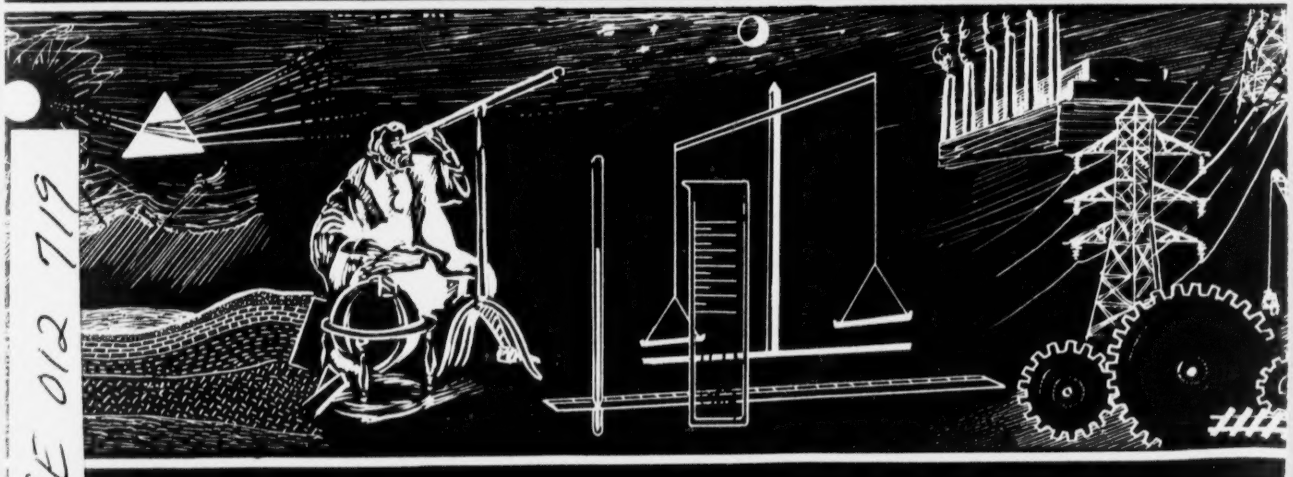
PRIMARY

CURRICULUM GUIDE

SCIENCE

A: BEGINNING SCIENCE



SE 012 719

CURRICULUM GUIDE

PRIMARY SCIENCE

A. BEGINNING SCIENCE

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HOW TO BEGIN

AN INTRODUCTION TO THE CURRICULUM GUIDE

Science has an important place in the primary school. Taught in the way advocated in this Guide, science can assist in the development of a style of thinking which has a wide application. It can lay a basis for later work in science, mainly by providing a variety of experiences and developing the pupil's ability to think.

The Process of Science

One way of looking at science is to regard it as a series of ideas that explain, or link together, a large number of observations ; the ideas suggest further experiments and observations, and so help to extend our knowledge ; in the process of investigation our ideas may have to be modified or even abandoned. Modern science does not deal in absolute truths, but in explanations that are known to be approximations in accord only with our present knowledge. There is an important principle here for teaching—that the teacher should not hand out " facts " that go far beyond the evidence the children have been able to collect. For example, the class may decide, with help, that air in bicycle pumps, tyres, balloons, and plastic bags is " squashy ". It is certainly not scientific, with young children of primary school age, to talk about molecules and the space between them.

Science and Direct Experience

Children need experiences that will help them to form general ideas. For example, if children are to gain an idea of liquids they need experiences with many different liquids—not only water, but also oil, detergent, vinegar, honey, and others.

The experience should be direct, with each child, so far as it is possible, working personally with the materials.

Forming Ideas

Children should be encouraged to express the ideas that they develop during their activities. To do this they may paint, make models, and, almost certainly, write. The actual doing of these things is not simply a form of expression or a communication of ideas ; such activities represent ways in which the child forms ideas and then makes them part of his range of concepts.

Science Is a Social Activity. It arose from man's efforts to understand and/or bring order into the information obtained from the environment, and then to use this information to make his life easier. When children work together to make bricks or grind wheat they are gaining some understanding of an aspect of science. Much of the stimulus to scientific thinking comes from the interaction resulting from working together at the problems that arise. Group discussion is an important part of science.

Science Activities Should Be Enjoyable. This can be so if the activities are difficult enough to interest children, but not so difficult that the ideas are beyond them. Many organized science activities should be preceded by relatively unstructured play. The processes or the materials that we are concerned with should be played with before they are purposefully manipulated or used.

THE CONTENTS OF THE CURRICULUM GUIDE

A. Beginning Science

Part I : Discrimination and Classification

Part II : Interactions and Change—
Inanimate Materials
Energy and Forces
Life

B. Following On

Part I : Matter

Part II : Energy

Part III : Life

C. Branching Out

Part I : Matter

Part II : Energy

Part III : Life

Each section of the Guide sets out important ideas and suggests topics around which experiences will develop. The suggestions in this guide are not mandatory. There are many other activities that would be as useful as those listed. The teacher should make use of any opportunity that arises from the local environment, from the out-of-school experiences of the children, or from any other incidental event.

HOW TO USE THE CURRICULUM GUIDE

1. First, the course should be read through so that it can be viewed as a whole. The Curriculum Guide is divided into sections only for convenience of presentation. Do not imagine that in " Beginning Science " a month must be spent on " Discrimination and Classification ", followed by a month on " Interactions and Change ", or that in " Following On " a term must be spent on each of the main sections—" Matter ", " Energy ", and " Life ".

   Work in the various sections should be interwoven and should proceed more or less simultaneously.

2. Note the emphasis in the Guide on—sensory experience, close observation, planning activities, carrying out the activities, measuring and graphing, organizing information, and language. These points should be kept in mind and no opportunity lost to develop them.

3. Keep the time allotment flexible. In one particular week more time than usual may be spent on science and a time adjustment made during the following week. Remember also that often science will blend with mathematics, language work, library activities, social studies, art, music, and physical education. This makes a detailed time allotment undesirable.
4. The span of interest and attention of young children is short, therefore it should not be expected that work on a topic such as " Rocks " can be kept up as the sole interest for a month.
5. Generate an interest in as many topics as possible early in the year, so that children can have variety in their experiences. Children tend to keep coming back to topics that have already been introduced earlier in the year.

6. Work will grow out of children's interests. Use the Guide to build on these. Remember also that at times the teacher will be the initiator.
7. When suggestions for activities come from the children, assign tasks to particular class members and work quickly while interest is still high.
8. When a question arises, ask the children *what they think.* Take note of their answers and questions, and use these for developing activities.
9. Do not worry if the work on a topic does not arrive at a neat and tidy conclusion. It is a mistake to think that children should get all the answers. *No one knows all the answers in science.* At the end of a study there should be some questions left unanswered and the children should realize that there is still much to be discovered.
10. How much the children are told depends on the situation. At the end of a study, some brief comments may be in order, but these comments should not be developed into a full-scale survey of the topic.
11. Beware of giving children words without experience. Too many children talk glibly of molecules and energy without any understanding at all. Concentrate on providing experiences that children can be encouraged to talk and write about in a manner appropriate to their age.
12. Use science to provide material for the experience books, which are a valuable part of primary school work.
13. Let children write freely about their science experiences and do not worry if what they write is not always entirely relevant, at least from the adult point of view. Restrict them now, and later work may suffer.
14. Use a broad approach, using one topic to develop ideas from a number of the sections of the Guide.
15. Use themes, topics, and interests to help create classroom displays. After all, the proper place for children's work is not in their desks but around them, creating a learning environment in which each child can profit by the experiences of others. It is worth noting, in passing, how much more willingly children will work at writing, painting, and model-making when they realize that the fruits of their work will be shared, not hidden from sight. Communication of ideas demands constantly changing displays, preferably created by the children themselves.
16. Remember, wherever it seems fruitful, to create links with other subjects. If science begins with art and poetry, and later ends with them, so much the better.

PART I

DISCRIMINATION AND CLASSIFICATION

PART I

DISCRIMINATION AND CLASSIFICATION

Introduction

The process of discrimination involves the perception of likenesses and differences in things as the result of close observation, using the appropriate senses of sight, hearing, smell, touch, and taste. The process of classification involves an attempt to bring some order into the information obtained through the senses, by creating groups or categories on the basis of similarity or a common property.

Development of the ability to observe and classify at the infant school level may well have an important bearing on the subsequent development of the child's ability to handle and group more complex ideas. Therefore, many opportunities must be provided for the child to develop his ability to observe, to discriminate between things, and to classify, using the appropriate senses.

Activities involving discrimination and classification play an important part in science at all levels in the primary school, but they are of particular importance in the infant grades. In the Beginners Grade, children may note and discuss fairly simple likenesses and differences. By the time children reach Grade Two, they should be capable of more finely differentiated classifications. For example, children playing with differentiated classifications. For example, children playing with leaves in the Beginners Grade may observe that some leaves are green and some are yellow, and sort them accordingly, whereas older children may note that some are dark-green with a touch of yellow, some are light-green with brown tips, some have little " hills " around the edge, and some are soft and " holey ", and sort them on these bases.

While observation of similarities and differences is also an important pre-phonic, pre-reading, and mathematical activity, the emphasis in science is on the gaining of some understanding of the physical world. Whereas, in these other subjects, children tend to differentiate according to whether objects are identical or equal, in science, children are looking for some broad similarity, some underlying common property of objects which may be in other ways different. For example, in sorting textured materials, though their appearance, shape, and size might be quite different, some have the same feeling (e.g. roughness), and consequently may be placed in the same group.

GUIDING PRINCIPLES

Bases for Classification

There are many different bases for classifying things. Children should be encouraged to work freely, inventing bases as they investigate a collection of objects. Children should group things in their own way, on the basis of the properties that are meaningful to them rather than in ways determined or set by the teacher. Grouping is thus a form of creative activity.

Children may use an affective basis ; for example.

I like } these . . . (colours, scents, sounds, textures) ; or
I do not like }

they may use a more objectively descriptive basis ; for example, prickly, smooth, sticky, and so on.

Given freedom, children will often have imaginative, original, and interesting reasons for their groupings ; for example, " I don't like them nuts with the purple taste." (A beginner's observation.) Occasionally, other children may try to suggest the basis on which a child has sorted his objects.

By the end of the Grade II year, most children should be able to make a wide range of imaginative and original classifications, including some of an abstract nature, frequently using more than one factor. Some evidence may also be forthcoming in children's spontaneous comments and suggestions, indicating that they are actually developing the habit of looking for categories in many situations.

There is nothing to be gained at this stage by introducing formal classifications. Rather, it is preferable for young children to continue to develop their perception and awareness, and to create a great variety of individual classifications.

The Role of Language

Activities in discrimination and classification help to develop the child's ability to make categories—to group things and ideas—and to see relationships. This ability is a basic process in intellectual development, and it requires a rich sensory experience to which language must be applied. Where there is insufficient emphasis on language, thinking tends to be restricted to concrete situations and particular cases. Abstract thinking later in like may become difficult unless language is developed early, out of the child's concrete experiences. In school, science should not be separated from language work.

The child must be encouraged to use language freely as he explores the materials with which he is working. But he should not be forced to think and to use words in adult ways. The acquisition of language is a gradual process, owing much more to experience and social interaction than to the formal teaching of labels or " vocabulary ".

Children should be encouraged to use words naturally in their own ways as they observe, handle, and group their materials. The imposition of adult patterns at this stage tends to force the childish patterns to be suppressed. It is also possible that the formation of ideas is made more difficult because to the child the words supplied have less meaning or impact.

The teacher gains insight into the child's thought processes through becoming sensitive to the implications of the child's use of language. Where the child's comments are welcomed, he becomes confident and derives pleasure from his own thoughts and ideas. He enjoys being drawn out by the teacher as she occasionally asks such questions as : " What makes you say that ? "; " Why do you think so ? "; " What else could you say about them ? "

In the natural flow of discussion between the teacher and the children about their experiences, which is a part of the social interaction in the classroom, the children will acquire many words and ideas. Teachers should avoid forcing the introduction of new words. While a child is thinking out his ideas, as he is doing in sorting and classifying activities, it is desirable for the teacher to accept the child's own terminology.

Imposition by the teacher of " better " words may well interfere with the child's own thinking and telling of what is meaningful to him. On the other hand, words should be made available to the child, but only experience can tell when the line between " being made available " and " being imposed " has been crossed. When it has been crossed, sorting may become an activity to please the teacher by using the words she approves, rather than a genuine activity in creative thinking. Furthermore, the child may lose at least some of his zest for thinking things out for himself. The teacher may not like the use of " skinniest " to describe leaves that the child is sorting. However, rather than correct him when he is expressing his own ideas about his own observations in his own way, *the teacher should continually introduce new and appropriate words in the social flow of discussion in the classroom. Such words will gradually become part of the child's thinking and speaking.*

The following extract from a case study illustrates how a group of beginners thought about things and commented freely to the teacher, who accepted the children's level and did not try to impose facts and explanations for which they were not ready. In this extract the children were making observations before going on to sorting activities.

C. Rocks grow don't they ?
T. Why do you ask this ?
C. I saw some great big ones in Sydney.
C. I saw a great big one in the sea but there wasn't a lighthouse.
C. Rocks make fire if you bang them together.
C. This one is a sea shell.
T. How do you know they are shells ?
C. I see them at the beach.
C. This rock comes from the sea.
T. What makes you think this ?
C. 'Cos I know.
C. Big rocks come from the sea.
T. Do all big rocks come from the sea ?
C. They come from the hills.
C. This one's been to the beach—it's rusty.
T. What makes it rusty ?
C. It's been in the water a long time.
C. This one made my nose try to sneeze.
C. I think it's been in the sea and the water sneaked in.
C. Tiny creatures ate the holes in this rock.

The following example illustrates how a Grade II child talked about his groups while sorting leaves. " These (the leaves in this group) are the skinniest. These have got big veins. These are nice colours. These have got points on them." The pupil used his own child-like terminology as he worked out categories for himself.

Class Organization

Discrimination and classification activities may be done at the individual, the group, or the class level, whichever is the most appropriate for a particular experience. The essential requirement is that each child should have frequent sensory experiences of handling and sorting objects. He should not spend too much time as a passive onlooker.

An On-going Process

Discrimination and classification activities should be continuous throughout the three years in the infant school. The teacher should not work continuously and completely through this section and then leave it, but should give experiences intermittently as opportunities arise. In autumn, when children are interested in collecting leaves or berries and seed-boxes, observations and sorting may arise out of this interest. After playing with magnets and finding which objects the magnets attract, children may find ways of sorting the objects. If a road is being made nearby, children may bring rocks and stones to school ; these will provide opportunities for observation and sorting. In all sections of the course, grouping activities should be carried out.

Integration with Other Subjects

The creative teacher will find many ways of making the child's learning more meaningful by relating science activities to those of other subjects. For example, in social studies, after work on rocks, the child may become interested in the uses of rocks, the ways they can help man in building, concrete mixing, and road-making, and in methods of getting them from quarries. After work with sounds, a link may be made with creative activities in music. For example, children may try to make patterns of sounds out of the various objects they have sorted. Further relationships between grouping and music may be possible where the Carl Orff system is being used. After sorting wallpapers and fabrics according to feeling, children may engage in art activities in which they make collage arrangements out of different textures. A valuable relationship with English is developed when children tell about and write sentences about their discrimination and their sorting. Tremendous possibilities exist for making a great variety of " Experience Books " composed of children's sentences about their activities; for example, " Our Book of Shiny Things ", " What Our Magnet Attracts ", " Things You Can See Through ", " Our Book about Liquids ".

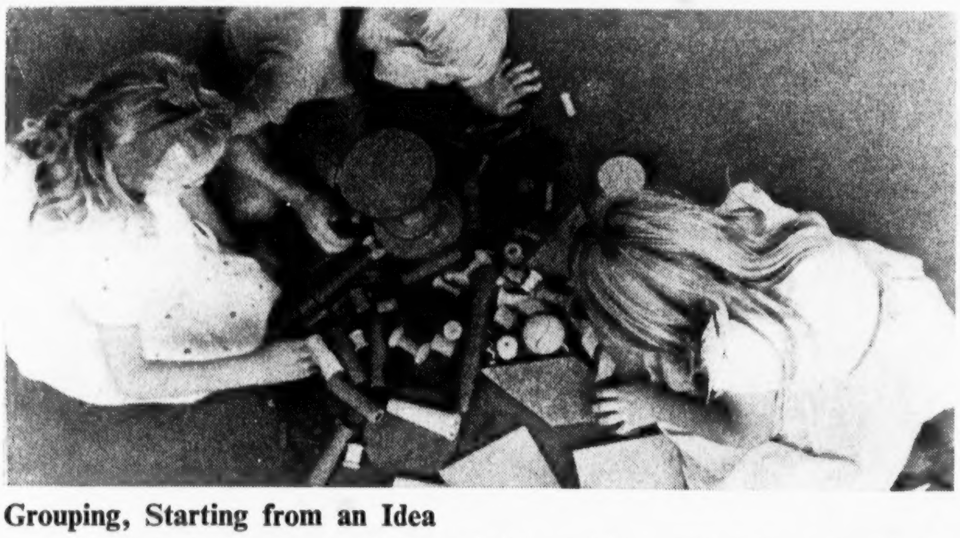
Note the similarity of much of the work in this section to introductory activities in applied number.

Topic Levels

It has not been found possible to assign a topic to any particular age group or grade. The same topic or material may be of interest to both Beginners and Grade II. However, it is to be expected that there will be a difference in the approach to discriminating and sorting by the five-year-old children as compared with that of the seven-year-old children.

The Beginners usually handle objects very freely. They enjoy the sheer sensory experience of touching, handling, moving, and playing with objects, and they comment in a fairly simple way. In the early stages they may try a little sorting into groups, but they are not always ready or able to tell what basis they have used, and it is unwise for the teacher to force answers which do not arise from understanding. However, a child's comments, such as " This rock has sparkles ", may give the teacher an opening to ask whether he can sort out some more rocks that have sparkles, thus preparing the child to look for similarities in things.

Grade I and Grade II children will come to handle objects more thoughtfully and examine them more closely. They will sort more readily, they will be aware of more detail, and they will take more factors into account in their discriminating and sorting. For example, they may find not just " black rocks " but " black rocks with sharp points " and " smooth black rocks ", using two factors in their groupings. The older children will more readily explain and give reasons for their groupings ; with maturity and experience they will use more abstract bases rather than simply visual ones. " These all hold water ", " These leaves are all from deciduous trees ", and so on.



Grouping, Starting from an Idea

Children often begin their activities with a collection of objects, such as seeds, rocks, or flowers, and sort them according to various common features, but another approach might be for them to start with a particular idea or attribute, such as shininess, things that smell nice, things that make a sound when blown, things that will roll, or spiral forms, and then find objects that fit into that category.

SUGGESTED ACTIVITIES

Introductory Activities

Before Beginners undertake sorting activities, they may be provided with a variety of experiences that will help to increase their sensory awareness and their capacity to perceive and discriminate using all the senses. Teachers may devise many of these themselves. Some examples are suggested here :

1. " *What Is It?*" *Type of Game*

   " I'm thinking of something in this room which is . . . " (hard, soft, light, heavy, etc.).

   " I'm holding an object behind my back. It feels . . . " (rough, smooth, soft, cold, tiny, etc.).

   " In this box I have something. I'll describe it. It smells . . . " (sweet, strong, etc.).

2. *Matching Games.* " I have a smooth stone. Who can find another smooth stone like this one ? " " What kind of stone have you found ? Is it the same as mine ? " Or with liquids : " Here is a liquid with a strong smell. Who can find another liquid with a strong smell ? " Later, more descriptive words may be added as the children gain experience. For example, a " smooth black stone ".

3. *Touch Games.* " I have something in this bag. Who can tell me what it is by feeling it ? " Later the bag may contain several things.

4. *Touch Table.* A variety of differently textured objects such as sand-paper, steel wool, textured wall-paper, fur, papers, and silver paper are placed on the table. After experimenting informally, children may play games. For example, " Find something rough (soft, smooth, etc.) ", or " Choose something and tell how it feels. We'll guess what it is."

5. *Sound Games.* Children move about, interpreting loud, soft, short, deep, hollow, or reverberating sounds.

   " Guess what the sound is."

   " Tell what kind of sound it is."

   Guessing games involving common sounds—for example, shaking tins of nails, cents, or marbles.

   Dropping objects behind a screen—for example, spoon, pencil, knife, book, or chalk.

6. *Smell Games.* Provide small brown-paper bags containing objects with characteristic smells—for example, moth-balls, fresh rubber, cheese, soap, chocolates, coffee, rag impregnated with floor polish, eucalyptus, etc. Children guess what is in the bags.

7. *Shape Games.* Provide a bag containing a number of objects of different shapes. Children feel inside the bag and describe the shape—for example, round, square, like a ball, like a box, like a star.

8. *Excursions.* Children go on excursions round the school-ground, out in the street, or to the park to discover big things, loud sounds, fast things, things that move, things that don't move, and so on.

9. *Collections of Objects.* Children make collections of objects with a particular attribute—for example, shiny, rusty, wooden, metal, plastic, tiny, round, rough.

10. *Jig-saw Puzzles.* Jig-saw puzzles and similar games that depend on arrangements of pieces of objects are useful for providing activities in perception and discrimination.

11. *Free-activity Periods.* In free-activity periods, the children will have many opportunities to make sensory discoveries in an informal way as they play with water, sand, clay, blocks, paints, and various types of waste material. They may smell, taste, feel, move, lift, examine, experiment, and comment.

12. *Seeing Likenesses and Differences in Sets of Objects or Pictures.* The teacher may show three or four objects with some common attribute and some difference and ask children to tell in what way they are the same and in what way they are different, for example, four blue buttons of different sizes. The children may tell that they are all buttons and that they are all blue, and also that they are of different sizes.

    Pictures of four squares of the same size but of different colours. The children may tell that they are all squares and that they are all of the same size, and also that they are of different colours. (Many of the matching exercises in pre-reading may be used for this purpose, but instead of just matching identical objects or finding the one that is different, the children should look for and describe underlying common attributes as well as any differences.)

Subsequent Activities

After the introductory activities, which may continue for some time with Beginners and be done occasionally in Grades I and II, children may periodically have some more ordered experiences in observing, discriminating, and sorting. A great variety of materials may be used, depending on the children's interests at a given time and the resources available in the locality. Materials which give scope for sorting using different senses include :

leaves
cloths
plastics
plants
animals
scents
rocks and stones

flowers
fabrics
household materials (liquids, powders and crystals)
trees
toys
fruits
soils

shells
wall-papers
metals
musical instruments
pets
vegetables
twigs.

Any of the above things may be dealt with in any infant grade. With the younger children, multi-sensory experience, observation, and discrimination may be the major activities. With the older children, more sorting and grouping on the basis of similarities may be carried out. This should be accompanied by explanations of the reasons for sorting and should show greater complexity and variety.

Suggested Procedure

At the outset of an experience leading up to grouping, there should be perhaps a week of informal multi-sensory examination and discovery by the children without undue guidance from the teacher. Children should be encouraged to bring relevant materials. These can be kept on the science table or in some acceptable place where in their free moments the children may handle them and make their own discoveries, talking freely to each other and to the teacher about them. During the week, the children might report observations and discoveries to the class to stimulate further examination of the collection. (N.B. There will be many times when incidental opportunities will arise for classification experiences in both science and other subjects in addition to those that are planned.)

When the children have had adequate time to observe, handle, and discuss the materials, they should be encouraged individually, in groups, or in a class lesson to sort objects that have something in common into groups. In the earlier stages, the teacher may give guidance by using a child's observation (for example, " This is rough.") to lead to a suggestion that he might put all the rough materials together into a group. Later, with some experience, the children will be able to sort freely and confidently into groups, without guidance from the teacher.

Informal argument and discussion should be encouraged. The children should not be made to feel that any one way of grouping is better than another. They should be encouraged to tell what is the basis of their way of grouping and challenged to find further ways. The teacher should listen closely to what children say, and value their utterances as a means of revealing how and what they think.

Either during preliminary investigations or after the sorting, discussion may arise about the nature, the uses, the sources, and other interesting details of the materials being studied. With experience, children might suggest simple experiments or tests they would like to try out with the materials. They might try bringing about changes in the materials and then re-sort them on the basis of the way they change.

Links may be made with other subjects. Often the children will draw and write about their experiences and make " interest " books. With the younger children, the teacher may write children's sentences below their drawings.

The following case study is an account of the work of a Grade II in collecting, observing, and sorting stones and rocks.

Stones and Rocks—A Case Study

Class, Age, Ability Range.—Grade II. Age 6–7 years. Mixed ability.

Number of Children in Class.—36.

Situation.—Owing to the fact that the paths and the grounds around the school had not been made, there were many different types of stones to be found. The soil was mainly clay, and as a result the rain had washed clay over the stones, leaving a reddish deposit on them.

How the Topic Began

One day an " emu parade " was organized and children were asked to pick up the stones that were lying in the grass, so that the lawn-mower could be used. While the children were doing this job, they found several interesting stones and slipped them into their pockets. Later they showed them to their teacher.

How the Topic Developed

The teacher and the children had an informal discussion about the stones, which were then placed on the science table for the children to observe informally. The children discovered that the stones were mainly of the same type. They then started looking for different types of stones. The children brought rocks from their own gardens, from rivers, roads, and the hills, and from the beach. When the children realized that there were so many varieties of stones, they became very eager to find interesting specimens and to talk about them and put them into groups. At this stage the pupils had not been asked to classify them, but the children did so, just the same. Their classifications were based mainly on colour and size. When the collection of stones had grown sufficiently, a more directed discussion took place on the different ways of *classifying* the stones, such as according to size, shape, and colour, or whether the stones were light or heavy, soft or hard, rough or smooth, brittle or tough, layered or unlayered.

Each child selected a favourite stone and then told the grade how it could be classified. It didn't matter how the child classified the stone, so long as he could give a good reason for doing so. Quite often one stone was put into different categories by different children.

The collection and the classification of rocks and stones went on for several months. The level of interest fluctuated. When interest was high, more work was done. The study was thus a continuing one. It stopped and started naturally, without a great deal of direction from the teacher. During the period when the workmen were digging the school-yard the interest was high, because rocks and stones were being brought into the school all the time.

The children were divided into groups of six and given a box of stones to classify into groups. All the children within a group helped with suggestions for classification. An interest book was made by the children about the rocks and the way in which they were classified. If the children so desired, they added extra notes or drawings to their page at any time.

The children didn't ask many questions. Instead, they made statements, comparing the stones with things they knew. For example :

Shape :

"It's round like a doughnut."
"Looks like a piece of wood."
"Looks like a staircase."

Colour :

"Black like a briquette."
"Colour of sand."
"Zebra coloured."

Smell :

"Some smell like the sea."

The rocks were handed around the circle for the children to feel. The teacher asked : "Do all rocks feel the same ?" (Answer : "No.")

The children said some of the rocks—

were flat like a pancake ;
were lumpy ;
had lines in them ;
were slippery, rough, smooth, etc. ;
felt heavier or lighter than others.

Later the children attempted to match rocks with samples classified scientifically.

From this study the children gained a knowledge of the great variety of rocks that were to be found and the various ways in which they could be classified. At the same time they increased their vocabulary and obtained a better understanding of the meaning of each word—for example, "soft" and "smooth". One child said that a rock was soft, when she really meant that it was smooth. After further discussion the child began to understand the difference between the two words. This was done by using different objects, for example, a piece of velvet and a sponge, to clarify in the child's mind the differences between the meanings of the words "soft" and "smooth".

EXAMPLES OF CLASSIFICATION

Scented Materials

(*a*) *Leaves*

Children may be encouraged to collect leaves that have a characteristic smell, for example,

gum
pine
wax-plant
tomato
cabbage
wallflower
aniseed
mint
lavender
geranium
salvia
onion
cypress
sage
bean
bay
nasturtium
thistle.

After several days of informal examination, the children should discuss the leaves—what they feel like, their smell, where they were found, their uses, and their names. Blindfold activities may follow the initial informal investigations. For example, a blindfolded child might be asked to select by smell a gum leaf from a variety of leaves.

Then, to introduce grouping, a child might be asked to choose a leaf and describe its smell. If he says the smell is not nice, he may then be asked to find other leaves to form a group of leaves that do not have a nice smell. In this way children may make a number of groupings, such as nice–awful, strong–faint, sweet–no smell. Pupils should be encouraged to think of and use more than one way of grouping. More advanced children may use several attributes, for example,

$$\text{sweet smell—}\begin{cases}\text{large}\\ \text{small}\end{cases}$$

no smell—rough

(*b*) *Flowers*

Children may collect flowers such as—

rose
hyacinth
mignonette
daphne
chrysanthemum
carnation
lemon
apple-blossom
wattle
bottle-brush
stock
nasturtium
jonquil
sweet pea
honeysuckle.

Opportunities to smell the flowers on the science table and to discuss them should be extended over several days.

Questions that may lead children to observe more carefully might be :

Do all red flowers have the same smell ?

Are all flowers fragrant ?

What flowers can you find that have no fragrance ?

Why do flowers possess a scent ?

As with leaves, children may undertake blindfold identifications, for example, identifying a rose among three or four flowers that they are given to smell. Then, to introduce grouping, pupils could find one flower with a certain characteristic (for example, " It makes my nose tingle.") and try to discover a group of flowers with or without this quality. Other qualities could then be chosen and groupings made.

(*c*) *Household Materials*

Experiences and classifications similar to those discussed above could be carried out with solids (powders, crystals, waxes, soaps, etc.) and liquids that possess a characteristic odour. These might include small jars of—

pepper
moth-balls
soap
vinegar
eucalyptus
tea
cinnamon
cheese
antiseptics
water
eau-de-Cologne
toothache drops
nutmeg
floor wax
milk
coffee.

N.B. Children should learn for the sake of safety to identify as soon as possible potentially dangerous substances. The teacher should use her discretion in introducing household chemicals to ensure that there are no harmful consequences.

After the children have been given the opportunity of smelling and naming household chemicals for a few days, they will comment on them and describe them. Their observations may then lead to sorting as, for example, when one is found to have a "burning" smell, pupils may try to discover if they can find others to make a group with "burning" smells. Then further groups, sorted on either an affective or a descriptive basis, may be made. For example, "These ones make me feel hungry." "These smell like the doctor's room." "These smell awful."

Problems associated with the liquids, which could be discussed and experimented with, are :

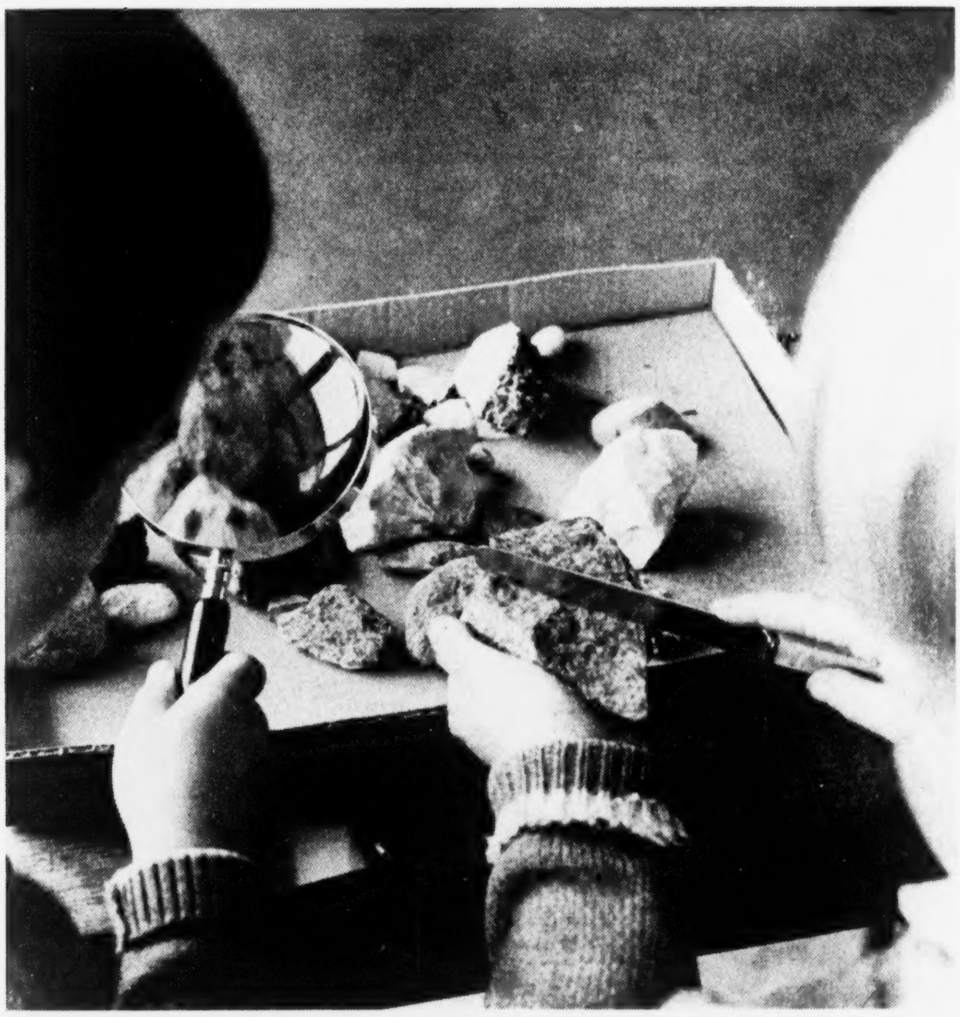
> Which odours spread round the room when different liquids are placed on pieces of cotton-wool ?
>
> If all of the liquid is poured out of a bottle, will all of the odour be poured out as well ? When children note that the bottle may still contain the odour, the teacher may ask them why they think this happens.
>
> If the colour of a liquid is changed, will the odour also be changed ? Cochineal and food colouring found in most kitchens can be used to effect the change. (Allow plenty of time for children to discuss their opinions before seeking an answer by experiment.)
>
> If a few drops of liquid are allowed to dry up in an open jar, would the smell still be there tomorrow ? Children may discuss the liquids which they wish to test in this way, and then carry out the tests.

Any work done on scents could become the basis of experience books containing pictures children draw and sentences they write. This exercise could be used for general English work and reading. (For example, "Our Book of Sweet Scents" or "Our Book of Strong Scents".) Advanced children may write these books themselves while others enjoy having the sentences they suggest written for them by the teacher. Older children may be interested in discussing the use of the sense of smell in animals, how animals hunt and track down their prey, and how dogs are used for tracking.

Rocks and Stones

Here again the aim is to encourage children to observe and sort materials, so that they become more interested in the materials and form the habit of approaching their environment in a way that will help them to understand more about it.

Both the teacher and the children may work together in collecting as many different rocks and stones as possible, and then handle and discuss what they have brought. Types of rocks may include :



Pumice (from the chemist) ;
garden gravel (grey and brown gravel, marble chips) ;
pieces of quartz ;
water-worn stones ;
ornamental stone (fences, fire-places) ;
roofing slates ;
stone used for garden rockeries ;
Mt. Gambier free stone ;
pebbles from creek-beds and beaches ;
road-metal.

This list shows that common ordinary materials are needed and that it is not necessary to use the more uncommon geological specimens. During their spare time or in free-activity periods, the children may, over several days, find out all they can about the rocks by smelling, feeling, weighing, scratching, and so on. They may use a hand lens, a kitchen knife, balance scales, an eye-dropper, a bucket of water, vinegar (if limestone is being used), or anything else the teacher thinks may help them to make discoveries about the rocks. Children should be encouraged to talk freely about what they have seen and done.

Following these introductory experiences, children working either in a group or in a class lesson may try sorting the rocks into groups based on some similarity. There will, it is hoped, be differences of opinion, but children may use any basis they wish. The groupings may arise from children's observation (for example, " This rock has stripes in it."), the teacher then taking the opportunity to ask the children to see whether they can sort out some more rocks with stripes and thus make a group. However, where the children are experienced at sorting, they may spontaneously work at making their own groups or the teacher may suggest that they make some groups of rocks that have something the same about them. Children could then explain the reasons for their groupings. Older children may be able to sort using several factors, for example, shiny black rocks, small sharp rocks, and so on.

The rock collection may be kept in several large tins and made available, together with a knife and a lens, at free-activity times for children who would like to do further investigating or sorting.

Handling of rocks may lead to an interest in collecting other hard materials, that is, the commencement of a study by an attribute rather than with a specific type of material. Children may collect such things as bricks, tiles, briquettes, concrete, charcoal, and coral. No distinction between rocks and the hard substances need be drawn clearly in the children's minds. It is enough to generate curiosity and thought and to have children express their own ideas at their own level of understanding.

Work on rocks may be related to other subjects. In English, children may make class, group, or individual experience books, using sentences in which they express their ideas about rocks. In art activities they might like to arrange their own stone or rock gardens in individual ways. In social studies they might discuss how rocks are used in the community (for example, for concrete, roads, paths, gardens, fences, and lighthouses), how stone is obtained from quarries, how precious stones and gems are obtained, notable rocks of the world (such as Ayers Rock), fossils in rocks, volcanoes, and so on.

Some samples of children's written sentences that illustrate the growth in perceptiveness and in awareness of difference from early Beginners Grade to Grade I are :

Beginners

These are all my rocks.
My rock is on the water.
My rocks are here.
Peter has some rocks.

Grade I

Some rocks are like crystals.
Our rock has holes in it.
Some rocks are jagged and some are smooth.
Some rocks are purple, brown, orange, white, and grey.
Some rocks are lumpy and some are middle-sized.

Twigs

Children may make collections of twigs and examine, smell, bend, break, scrape, rub, discuss, and classify them according to such attributes as whether they are alive or dead, sappy (juicy) or dry, straight or crooked, smooth or rough, grey or brown or green, or have buds showing or no buds showing. The sorting of twigs may lead to one of the attributes becoming the basis for a further collection (for examples, crooked things, rough things, parts of trees, and so on).

In late winter, samples of twigs with buds may be kept in jars of water so that children may observe the buds shooting. The following example illustrating children's observation of twigs is taken from a Beginners Grade during the first term of the year :

March 17th : Visit to the park to collect twigs.

March 18th : Observation and discussion by the children.

C. Some are bigger than others.
C. This one's bendy like a circle.
T. Why ?
C. The tree made it bendy.
C. It's like a moon (curved).

Several twigs had a fungus-like growth on them and were scaly.

C. It has leaves on it.
T. Are they leaves ?
C. Little leaves.
C. This one has bumps on it.
T. Why ?
C. Where the leaf was hanging on.
C. This one's smooth.
C. This one's straight.
C. It has pieces stuck on (fungus).
C. It's the seeds.
C. It has patches of silver because it's getting old.
C. Sawdust has blown on it.
C. This is lighter brown.

Two twigs were passed around for comparison.

C. This one's rough and this one's smooth.
C. This one's hard and this is soft.
C. This bark looks like wire (round).

The children then suggested that groups could be made of twigs that were very thin, fat, long, and of different colours.

Flowers

Children collect flowers and observe, examine, discuss, and sort them into groups according to whether they are perfumed or not perfumed, or on bases such as their colour, shape, size, petal pattern, type of stem, or the type of plant they came from.

Leaves

Children may sort leaves on many bases such as their shape, size, and colour, or whether they are limp or stiff, dull or glossy, smooth or furry, smooth-edged or bumpy-edged, scented or not scented.

Shells

Shells may be sorted according to shape, size, colour, or pattern. Older children may sort using two factors, for example, large and patterned, round and plain, or coloured and round. This could lead, perhaps, to a collection of objects with the attribute of having a pattern such as being striped or spotted. Children may use shells in their art activities, for example, in collage arrangements and shell gardens.

Soils, Earth, Sand, and Clay

Soils, earth, sand, and clay may be sorted according to colour or texture or what happens when they are mixed with water.

Textures

Various types of wall-papers, elastics, sand-papers, tin foils, tissue-paper, fabrics, leathers, furs, etc. may be handled, discussed, and then sorted into groups, especially on the basis of feel. Experiments such as trying to cut them, tear them, or stretch them may give further bases for sorting. Experience books, collage work, and social studies discussions on the sources and the uses of these materials may follow.

Liquids

A collection may be made of a variety of liquid samples in small glass jars. Preferably there will be more than one sample of each liquid. Some suitable liquids are :

- Water (of various kinds)
- honey
- molasses
- cream
- red, black, and green ink
- light machine oil
- face-cream
- golden syrup
- paraffin oil
- paint
- linseed-oil
- engine oil
- white sugar and brown sugar
- tar
- lemonade
- milk
- salad-oil
- coffee
- hand lotion

In appearance, many of the liquids are very similar. This means that various types of sensory observations will be needed as a basis for sorting. The opportunity should be taken to develop safety concepts about the need for care in handling, smelling, and tasting unknown liquids. If there is any doubt about the wisdom of using any of these liquids, they should be avoided.

After some days of informal examination and free discussion of the smell, the feel, and the appearance of the liquids on the science table, the children may begin to group them in their own way, finding many different ways of doing so. This may be done on the bases of colour, smell, and feel (forefinger dipped in liquid, which is then examined and rubbed between finger and thumb).

Eventually, liquids may be named and labelled, as far as possible by children, the teacher adding other names. Labels can be placed in front of jars, jumbled, and replaced correctly by the children.

When children have become thoroughly acquainted with the liquids they may try identifying them when they are blindfolded. In this way, they have to rely on a property other than visual. They may use a finger to dip into and examine the properties of a liquid or go by the smell ~~of the~~ liquid. Discussion may arise as to where the liquids are obtained, what they are used for, and the possible dangers in tasting.

In addition to sorting the liquids on the bases of these multi-sensory experiences, various other activities may be carried out which could give further bases for observation, demonstration, or, ultimately, sorting. For example, sorting according to the way in which various liquids evaporate, according to their viscosity, or according to what happens when they are mixed with water. These activities are suggestions only. It may happen that none is carried out either because the children are not sufficiently interested or because alternative activities come to mind.

The activities should not all be done in the space of a few days. It is probably better to proceed at a leisurely pace. If the liquids are labelled and set out on the science table, they can then be handled by the children, looked at, talked about, or perhaps ignored for some days or even weeks. Then, if the opportunity presents itself, further work might be attempted.

Note.—The aim of these activities is to encourage children's observation, classification, and oral English. The teacher should not feel the necessity to teach a number of facts about liquids.

Sorting According to the Way Liquids Evaporate

Children may become aware of the process of evaporation as a result of a variety of observations. They may observe such things as puddles drying up after rain and the water level gradually falling in a fish bowl or a vase of flowers.

In observing different rates and effects of evaporation, for fairly rapid results children may smear a little liquid on to a dry surface and watch what happens. Another way is for a child to place a single drop of water in a saucer, using an eye-dropper, just before the end of the afternoon. Children may be told the drop of water will be examined in the morning to see whether it looks the same. To ensure that the drop of water will have evaporated, the saucer should be left in a warm place. The following morning children note what has happened to the drop and suggest where it has gone. There is no need to give them the answer. If a child gives an unusual explanation he can say why he thinks so, and the matter can be left unresolved.

This experience may then be used to develop an interest in whether the other liquids collected by the class will also evaporate. Children should be encouraged to make forecasts about this. Then they can experiment with very small quantities of these liquids in saucers or in tin lids. Eye-droppers should be used if available, and the liquids left until the next day.

Finally, the children may be encouraged to sort the liquids into groups according to whether the small quantities of liquids used will evaporate in a stated period of time.

Sorting Liquids According to Viscosity

Another activity with liquids is for the children to lift up the liquids on spoons and to see which ones are thick and sticky enough to make " threads ". This could give a further basis for grouping.

A variation of this activity can be undertaken with pill tubes containing each kind of liquid. A marble is put into each one and the children watch the rates of descent of the marble, and then describe and classify the tubes according to whether the marbles drop quickly or slowly.

Tightly capped pill tubes of liquids could be left on the science table indefinitely, so that the children could experiment with them, turning them upside down, noting such things as the rate at which the different liquids moved back to the other end, and sorting them accordingly.

Water-mixing Activities

To introduce this activity, the class may watch while a child makes up a glass of fruit cordial and water. After the children predict what will happen, they note how the two liquids mix. Children might guess whether they think the liquids on the display table will mix with water.

Next, children with stirrers (icy-pole sticks) and small jars half-full of water may experiment in pairs. Each pair takes a jar, adds one of the liquids, and stirs. Then the jars are labelled with the children's names and allowed to stand for some minutes (perhaps during the play recess). Later, the children can tell the class what liquid they tried to mix with water and what were the results of the experiment. As a result, children should see a further classification—liquids that mix with water, liquids that sink to the bottom, liquids that stay on the surface.

If the water-mixing activities prove interesting to the class, the children might try other mixtures to see what happens and to work out classifications for them. For example, coffee and salad-oil, golden syrup and vinegar.

Powders and Crystals

The following is a suggested plan only. As far as possible children's interests and suggestions should be followed. Teachers may have their own ideas about the experience to be provided.

Children may bring a variety of household powders and crystals. These could be stored in small glass jars. Some powders should be similar in appearance, such as flour, icing-sugar, white powder colour, fruit saline, and castor-sugar. This will increase the need for careful observation and, as the differences emerge, the children are more likely to become curious and interested.

Some suitable powders and crystals that are readily available are—

- salt
- flour
- pepper
- coffee powder
- powder colours
- baking soda or cream of tartar
- fruit saline or health salts
- sugar (dark-brown, light-brown, white, castor, icing)
- powdered milk
- cinnamon
- food dyes.

Note.—Once again it must be stressed that the observation and classification activities should be performed by the children themselves. They should participate actively, not merely watch the teacher. The value of the work does not lie in teaching facts about castor-sugar or powder colour but in practising skills of observation, using all of the senses, discussion and classification, handling materials carefully, and learning to behave in a responsible way by working together in group activities. The children may learn something about the properties of certain powders and crystals, but they should learn as a result of their own activities.

The work with these materials should also allow opportunities for safety-first talks emphasizing the need for care in handling unknown substances and the dangers involved in testing them.

The jars may be left on the display table for informal observation until the children are familiar with them. They may identify some of the contents, but the teacher should not tell them or label the jars at this stage. The important thing is for the children to observe closely the properties of these materials and to comment freely. Early naming tends to forestall careful observation. Putting out small quantities of the powders on paper plates enables the children to feel and smell them more easily. Tissues should be available for children to wipe off one powder from their fingers before handling another.

After some informal handling of the materials children, individually, in pairs, or in groups, may be asked to sort the powders into groups in any way they think suitable. They may choose to base their groupings on colour, texture, or smell. Possible colour grouping might be :

brown—brown sugar, crushed brown chalk, cocoa, coffee powder, cinnamon ;
yellow—milk powder, mustard powder, custard-powder, curry-powder ;
blue—powder colour, light-blue crushed chalk ;
white—sugar, cream of tartar, baking soda, fruit salts, table salt.

In texture classification, children may use as a basis a difference they can see or feel. They may group substances as being smooth, grainy and lumpy, sugary (or glassy), or powdery. The teacher should encourage the use of words such as " crystals ", " fine ", and " coarse " where appropriate.

Find the Pair

A class activity at this point might be a game where a child chooses a substance to show and describe. Another child might then attempt to pair this substance with one on the display table.

Water Mixing

An activity for more advanced children might be for the children to experiment to see what happens when powders or crystals are mixed with water, stirred, and left for a time. The children might observe that some substances dissolve, some form a sticky paste, and some do not dissolve at all. They may also discover that when powders are sprinkled on water other results are obtained. Discoveries arising from mixing operations could become the bases for further sorting.

Evaporation

Advanced children might observe what happens when small quantities of some of the saturated solutions made by the children are left on saucers on a window-ledge. In this way, some of the powders and the crystals might be recovered by the process of evaporation. No explanation of this phenomenon need be attempted. There is sufficient justification for the activity in the amount of curiosity that can be aroused.

Finally it is worth repeating that all of these activities provide opportunities for discussion. The oral expression work that takes place should be regarded as developing an important communication skill (and helping children's intellectual growth). This is just as much a part of English as it is of science.

A case study, which illustrates work involving powders and crystals, is given below. It illustrates how children think and how the teacher encourages children to think at their own level.

Observation and Sorting—Powders and Crystals

Grade I, Term I

Preparation—the children collected and observed powders on the science table for a period of one week. They had looked at the powders, shaken them, felt them, smelt them, and tasted some.

Class Session 1

All children were curious and interested. Powders were put in the middle of the floor and then passed around. No direction was given by the teacher.

Comments on various powders:

C. It smells nice.
C. It's jelly crystals.
T. How do you know?
C. It's like sugar but it's coloured.
C. This one looks like sand. Sand hasn't got a smell.
C. It is like sugar. It is soft. It smells awful.
C. This one looks like pepper. It is yellow and it smells awful.

C. This smells like Rinso. It's not soft. It's kind of hard. It makes you sneeze.

One child then said : " I have a yellow powder and so has Suzanne. But I have a darker yellow than Suzanne's."

T. Can you see any other yellow ?

The child then collected all the yellow powders and put them together.

C. This one is yellow, this one is a light-yellow, this one is a little bit more light, this is the darkest.

T. Can you see any others you would like to put together ?

C. I can see some *browns.*

Child then put them together.

His grouping—dark-brown, light-brown, middle-brown.

C. Here are some *whites.* Some are a darker white than others.

Other children then grouped their powders together—reds, greens, blues, etc.

Written expression then followed.

Class Session 2

Interest was now aroused.

T. I want you to close your eyes and see if you can find out anything else about the powders.

Comments :

C. Feels lumpy.

C. This one feels soft and sticky.

C. It smells like Tarax and it's sticky.

C. This one has a fizzy smell.

C. This smells like coffee. I like it but I don't like tea.

C. This one hasn't got a smell.

C. This one smells terrible.

C. This smells like Omo or borax. It's not very nice.

C. This is not a very nice soapy smell.

C. This one nearly makes me sneeze.

C. It smells like what mother makes cakes with.

C. This one feels lumpy but this one feels smooth.

C. This one is hard like little stones.

C. This one is soft.

One child then said : " Some of them have *nice* smells and some are *awful.*"

T. Show me the powders that you think have nice smells.

Child smelt some and grouped them together. He made two groups.

T. Why are there two groups ?

C. These are the ones with nice smells and these are the ones with awful smells.

All children then discussed the powders they liked and the ones they didn't like. Most children liked " fizzy ", baby powder, and coffee. The powders least liked were curry, pepper, spices, and onions.

C. I know some that have a very strong smell.

The child then sorted his powders into three groups—those with a strong smell, those with little smell, and those that had no smell.

Written expression followed. Some of the sentences written by the children were :

Our powders have all different smells.

Some powders make you sneeze and some don't.

The powders are different colours and some are smooth and some are rough.

Some powders can dissolve in water and some powders can't.

Some powders are fizzy and some go thick like paint.

Judith's coffee turns black when you put water on it.

The powders are pretty and when you put them into water they turn a dark colour.

My brown sugar melted into the water.

In subsequent sessions, working in a similar fashion, the children sorted in other ways : sticky or not sticky ; smooth and soft or hard and lumpy ; crystals or powders.

This work led to a study of evaporation, which proceeded on the following lines.

Evaporation Study

The children chose some powders and crystals to leave overnight in saucers with a little water to see what happened. The next morning the children noticed that there was no water left.

T. Where did the water go ?

C. You tipped it out.

C. A mouse drank it.

C. No, it dried up.

C. It has melted into the clouds.

C. It floated up and made clouds.

C. It evaporated with the air and is going up to make clouds.

T. What is left in the saucers ?

C. Our powders and crystals.

No explanation was given by the teacher. This was left for the children to work out for themselves.

Sounds

Teachers may find a variety of ways in which the work may be developed. Perhaps it may start as a game, for example, " What do these sounds remind you of ? "

Drum fingers on the table top (horse galloping).
Make a "sh"-ing sound (waves on the beach).
Make a whistling sound (wind in the trees).
Tap a finger-nail on the table (a dripping tap).
Clink bottles (milkman delivering the milk).

The children will provide further examples and the game can be continued for several days, giving practice in listening and in oral expression.

Mystery Sound Box

Further experience in and development of listening skills can be helped by the use of a large cardboard "mystery sound" box. This box could contain such things as :

paper
an egg-beater
pieces of wood
a bottle
twigs
coins
metal
a flour sifter
sand-paper
a half-empty matchbox
stone or brick
a file.

The children may first see each article, hear it make its sound, and find words to describe the sound. Then they take it in turns to conceal their hands in the box and produce sounds. The other children should be encouraged to discriminate carefully between the sounds and to describe them accurately. The sounds identified might include—

the whirr of an egg-beater,
the tearing of paper,
the clink of a bottle,
the rattle of matches,
the rasp of a file,
the snapping of twigs.

Other Discrimination Activities

Several matchboxes containing different quantities of matches might be used and the children could attempt to discriminate between the sound of many matches rattling in a box and a few matches rattling. They could also note the different sounds made by a coin striking a glass bottle, wood, stone, or metal.

People's Sounds

Another activity is to note the sounds produced by different people—girls, boys, and adults—when talking or walking. Sounds could be made out of the children's sight in order to provoke discussion.

Musical Instruments

A further experience can result from the children and the teacher making a collection of toy musical instruments (for example, toy piano, xylophone, drum, trumpet, tambourine, recorder) and other objects that produce sounds if tapped, plucked, or blown (for example, rubber bands stretched over a box, large bottles and small bottles, bottles of the same size containing different amounts of water over which children blow, tins, paper and a comb, narrow-necked bottles (if children blow across the top of a bottle they will produce a flute-like sound), gum-leaves, and privet-bush leaves (blown by older boys).

The children may try out all the sounds that can be produced with these articles. They will probably make the discovery that all sounds are the result of some form of movement. By feeling their throats, as they make a sound, they will realize that even their own speech is a product of movement.

Classification of Sounds

It will probably be enough for younger children to develop their auditory awareness by identifying common sounds and experimenting with the kinds of sounds they can produce from different objects.

However, older children may be interested in undertaking some grouping activities. For example, a child may tell how he made a sound by blowing a tin whistle. This could lead to the working out by the children of a group of objects that make sounds when blown. Similarly, children may make groups of objects where sounds are made by being plucked, by being shaken, or by being tapped. Children may find other ways of sorting according to the quality of the sound—for example, pleasant or unpleasant, sharp or sustained, loud or soft, high or low, sad or happy, tinkling or jingling, sounds that the children like or sounds that they don't like. As an alternative, the children may be given a category (for example, kitchen sounds or football sounds) and think of appropriate sounds to put into the group.

Animal Sounds

Younger children may imitate and name the sounds of birds and animals, while older children may go further and classify animal sounds as loud, soft, pleasant, unpleasant, harsh, or fierce.

Related Activities

The work on sounds may overlap music activities, where children do appropriate movements to illustrate the sounds or give appropriate sounds for a movement.

In the English period, many interesting experience books may be compiled by individuals, groups, or the class as a whole. Examples of such books could be : " How Sounds are Made " ; " Our Book of Loud and Soft Sounds " ; " Our Book of Animal Sounds ".

Seeds

There are a number of ways in which work with seeds could be introduced. One way is to present a group of children with a container holding a number of different small objects, including a variety of seeds. Seeds such as pea, bean, radish, cucumber, sweet corn, and sunflower, as well as other small objects such as small pebbles, small ball-bearings, gravel, bits of fibro-cement, and small pieces of charcoal, may be put into small jars. These objects should not be identified by the teacher.

After handling and examining the objects, the children may be asked to sort them into groups that have something alike about them, and perhaps to explain to the teacher why they have chosen particular groups. The whole class may discuss what the objects might be. " Are any of them seeds ? Which ones ? Why do you think so ? " The children may criticize each other's comments and be ready to upset the " too-definite " statements made by some children, by using examples or by asking questions. The teacher should listen carefully to children's comments in order to gain an idea of their level of understanding.

The next stage is to determine which are seeds. This is a case where observation alone cannot give the answer ; observation under certain special conditions is necessary. This is the experimental approach. Here the children may find out about things by doing something to them. The teacher should encourage the children to think of what could be done to find out which are seeds. If some child does not suggest planting the seeds, the teacher might discuss whether it would be better to plant all of the objects or only those that the children think might be seeds. There should be agreement that the only way to be certain would be to plant all of the objects. The objects can be put in boxes of sand, in flower pots, or in tins (with holes in the bottom) and labelled with sketches of the objects, or a seed could be stuck on the outside of each container. All the seeds listed above will germinate fairly rapidly (in up to about twelve days) in warm weather or in a warm place. Planting seeds near the side of a glass jar enables everyone to see what is going on. Beware of over-watering, especially if there is no drainage in the jar. The seeds should be planted to a depth of about half an inch and observed daily for several days. Some of the seedlings may be planted out in the garden or kept in indoor pots or tins to be used for an activity from the " Life " section of the course. Planting the seeds is an activity related to the " Interactions and Change " section, and illustrates how a seed may be changed when given moisture.

Cloth

Materials may be classified according to colour, weave, texture, ability to withstand crushing, and type (woollen, cotton, silk, nylon). Children may try wetting the cloths, and this may lead to sorting on the basis of water absorption or length of time taken to dry. As a further activity, children might use different pieces of cloth to make a collage picture or a pattern.

Solid Materials

After examining and experimenting with solid materials, such as various metals, plastics, cork, rubber, hessian, and canvas, the children may sort them into groups such as hard or soft ; light or heavy ; those that float or those that do not float ; those that are waterproof or those that are not waterproof. Much incidental discussion about sources and uses, and topics related to the social studies course, is likely.

Plants

Plants may be examined and sorted according to colour, size, kind of flowers, leaves, roots, seed-boxes, place of growing (habitat), uses, and so on.

Vegetables

Vegetables may be examined and sorted according to attributes such as colour, shape, whether they grow above or below the surface of the ground, what part is eaten and whether they are eaten raw or cooked.

Fruits

Fruits may be examined and classified according to colour, shape, size, skin, flesh, and size of seeds.

Pets and Other Animals

Using pictures, groupings may be made according to size, colour, food eaten, way of moving, kind of coat, kind of sound made, and so on.

Toys

Groupings for toys could be toys for girls or toys for boys ; toys that move or toys that don't move ; and so on.

Books

Pencils

Children

Miscellaneous Collections of Objects

Children may find some common attributes among miscellaneous objects, thus enabling them to make groupings, such as objects made of plastic, wood, or tin ; objects that hold things, or float, sink, burn, tear, break, fold, and so on.

Large tins of mixed objects may be made available for sorting by individual children in their free-activity periods.

The teacher may periodically challenge children and evaluate their level of thinking by showing them several assorted objects or pictures and seeing if the children can find common attributes, for example, a brush, soap, and a rag (all used for cleaning) ; a tin, a box, a tube, and a bag (all used to hold things). Children may often surprise the teacher by thinking of some common attribute that the teacher has overlooked.

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A Final Note

The ideas in this section are suggestions only. In any one classroom, science experiences may follow a different pattern.

Classification activities should be related to other work on the same topic wherever possible. For example, classification work with liquids should be taken in conjunction with the work in the " Change Section" and classification of animals should be related to the " Life Section ".

PART II

INTERACTIONS AND CHANGE

PART II

INTERACTIONS AND CHANGE

CASE STUDIES

The Effect of Vinegar on Various Substances

School : Small rural school.

Age Range of Children : Five years to six years six months. During the work, children in Grades III to V became interested and were allowed to join in.

How the Work Began

Previously, the children had been working with powders and liquids on a fairly informal basis. In this particular activity the teacher provided the initial stimulus.

The Materials Used

Icing-sugar, barley, white table sugar, washing soda, vinegar, eye-droppers, small tins, and a number of containers for the substances being used.

How the Work Developed

The period began with a brief tasting and smelling session. This gave the teacher an opportunity to reinforce previous warnings about dangerous substances.

A small amount of icing-sugar was placed in each of a number of tins, and the children, working in pairs, added vinegar and mixed the substances together. The general observation was that the icing-sugar became sticky.

The procedure was repeated for each of the remaining substances.

The following were the main points observed :

Barley	—went "darker" and could be picked up on finger. The mixture was very sticky.
White sugar	—went darker and "melted" when the vinegar touched it. When sufficient vinegar was added, the sugar "melted" completely. After much discussion it was decided that "dissolved" was a better word than "melted".
Washing soda	—the children had observed that washing soda looked like glass chunks and ice. When the vinegar was added the following points were made : " It went more clear." " It melts a bit." (Note that the distinction between " melts " and " dissolves " is still not quite clear.) " It's frothy around the edges." " It jumps out of the tin."

The children watched the bubbles and listened to the fizzing until the reaction stopped. The children tried to start the reaction again by adding more vinegar and were successful. When it stopped more soda was added but nothing happened.

At this stage the older children became interested. Lighted matches were placed over the bubbles and the children were intrigued when the flames were extinguished. Using fresh materials in a milk bottle, the experiment was repeated. This time a balloon was stretched over the neck. The children were highly amused to see the balloon swell as it filled with gas. When asked what was happening the young children suggested that the bubbles were filling the balloon. No attempt was made to refine this answer for fear of imposing a half-understood idea and producing verbal responses which might hide the real level of understanding at a later date.

The activity was followed by written work appropriate to the level of ability of the children.

It can be seen that the activity provided the children with a number of opportunities to develop their ability to observe and describe changes, and to sort out the factors involved. It should also be clear that the teacher needs to refrain from introducing adult ideas and to restrain children from reproducing similar ideas, which they are not yet ready to use. At the same time, by listening to what the children say and the manner in which they express themselves, both orally and in writing, it is possible to learn something of the level of mental operation of each child.

Experiences with Air

Melbourne Suburban School—Preparatory Grade and Grade I.

Work began with a floating and a sinking activity. The children brought along empty jars (with and without lids), plastic bottles (sealed, and one with a very small hole), ping-pong balls, blocks of wood, corks, brass rings, and small pieces of metal. These articles were immersed in a baby's bath which was two-thirds filled with water.

Children commented freely before and after trying out the objects in the water. Most thought the plastic bottles and jars would float, but no reason was offered. All agreed that the heavy blocks of wood would sink, and were surprised when they floated. There was no doubt in the minds of the children that the ping-pong balls and the corks would float, but some children imagined that the brass rings would float because they could see through them.

The next step was to push an empty jar, open end first, into the water. The children felt the inside of the jar both before and after immersion, and were amazed to find that it was still dry. The children repeated the experiment later, working in pairs at buckets.

The children tried many ways of filling bottles in the baby's bath, all of them clamouring to try their own particular way.

Corks were floated on the water and open jars were pushed down on them. The children saw the corks go down, but could not understand why. They did this individually and were fascinated and kept asking " Why ? " The problem was discussed, but it seemed beyond the comprehension of most children that the air in the jar did not leave space for water to enter. One child was not at all surprised and said that if a tissue was put into the bottom of the jar it would remain dry. The child demonstrated this, and as a result some of the children seemed to have more understanding of the idea of air taking up space.

The children appreciated that bubbles were composed of air coming out of bottles and jars. They gave many instances of seeing bubbles in other circumstances. The children were interested in the noises made when water was poured from bottles and jars, and they talked about splashing sounds, the gurgle of water running out of baths and sinks, and the sound of waves on the beach.

Sufficient bicycle pumps were brought to the school to provide one for every four or five children. Some children helped blow up a rubber ball, using a special valve. The children knew that air came from a pump and they realized that when a finger was put over the end of the pump it was hard to push the handle down because the air couldn't get out. Further talks continued, and the children talked about the " hard air " that was in car tyres, and that could be obtained at the petrol station or put in with a pump. One child said that air was in bicycle tyres but not in tricycle tyres.

When the rubber ball was deflated under water, the children became quite excited about the bubbles escaping and the ball getting smaller. The children then individually played with balloons, blowing them up and allowing them to deflate under water. Some children were surprised that no air came out when the balloon was deflated, but some of the other children soon told them that it was because there was no more air left.

A candle was lit and the children watched, commenting on the way it burned. A large jar was produced and the children were asked what would happen if it was put over the candle. Several children said the flame would go out because it would have no air. This was the case, and the rest of the children seemed to comprehend almost immediately that the candle needed air, and they offered many suggestions as to how far over the candle the jar could go before the flame would go out. Different ways to put out the flame of the candle were suggested.

The children made parachutes—generally a large handkerchief tied with string at the four corners and with a weight underneath. These were thrown into the air and the children watched to find out how long each would stay up in the air. Paper kites were also made. Several children also had kites at home, and a discussion took place about the best conditions for flying them.

Cooking

Class, Age, Ability Range : Grade II ; 7–8 years ; wide range of ability.

Number in the Class : 36 children.

Situation : A modern school in a fairly new suburb. There was a power point in every room. An urn, an electric frying-pan, and a pie-warmer were available.

How the Topic Began

Each Friday afternoon Grade V and Grade VI girls took turns at cooking afternoon tea. The smell of the scones, fritters, and Welsh cakes wafted down to the Grade II classroom and the children asked if they could do some cooking.

How the Topic Developed

The children started by making chocolate crackles. They weighed the dry ingredients and mixed them—a practical application of applied number ideas. While one group of six worked at this task, a second group was busy copying the recipe. A third group weighed the copha. When all was ready, the groups came up in turn to the frying-pan to melt their copha. Previously the need for care had been emphasized, and the earlier warnings were repeated.

The teacher supervised the melting of the copha and the handling of the hot pan. The children had observed that the copha was solid before it was placed in the pan ; now they watched as it changed to a liquid. The other ingredients were added, and the mixture was then spooned out into pattypans. The children remarked on the way the mixture solidified.

The following subjects were treated during the lesson : applied number, science (the changes that occurred in the copha when heat was applied), health (the importance of clean hands, clean utensils, and clean surroundings), written expression (the children wrote about their experiences), safety (the need for care when using electrical appliances and hot pans), social studies (mother's work in the home), manners (the need for self discipline was stressed constantly as the children worked and, later, as they handed around the food).

Some weeks later the children made spaghetti and meat sauce. Once again the children were divided into groups, each with a particular task, cutting up onions, mincing meat, preparing the spaghetti under the supervision of the teacher, and setting the tables.

The children found that the onions had a strong odour when raw, and their eyes began to water when they cut up the onions. One child sampled a piece of raw onion and remarked that it wasn't very nice. But when the onions were placed in the pan the children noted that they began to lose their strong odour and, in its place, a delicious smell arose and the onions changed colour. The children commented on the fact that the taste changed also. The cooked onion tasted sweet.

The children also noted that before the meat was put in the pan it was red. As it cooked, the colour changed and the meat turned brown. The smell of the cooked meat was also completely different from that of the meat in its raw state.

At this stage the children were busy looking for changes. The crisp, thin spaghetti was placed in the water. After several minutes the spaghetti was soft, pliable, and fat, and the water had turned cloudy.

On subsequent occasions the children made pikelets, jellies and instant puddings, and scones. Every opportunity was taken to emphasize the scientific aspects of the work.

Stimulated by this work, the children in a lower grade also tried their hand at making bread. They watched in wonder as the mixture started to rise under the cloth that was covering it. The teacher had not told the children about this previously, and now they commented freely. One child said there was an animal under the cloth ; another child explained what was happening by saying that the fairies were fixing up the bread so that it would be good to eat.

What the Children Got from the Topic

Apart from the very considerable learning that occurred in other areas, a good deal of science was studied. Children learnt that :

(*a*) Foods change in a variety of ways when heat is applied ; cooking changes the flavour of foods ; foods often change colour ; foods may lose their smell or acquire another (e.g. onions, eggs) ; foods often undergo a change of state (e.g. an egg when raw is in a liquid state, but when cooked it becomes a solid).

(*b*) Foods often change when subjected to cold in a refrigerator ; liquids may become solids and substances such as jellies and junkets become firm.

(Note.—Cooking is not an activity one would undertake every day in an infant school, but the method of attack described above can be applied in many other situations during which interactions and change are being studied.)

Study of Light and Colour

Grade I, Term II

How the Work Began

Children's comments :

" There's a rainbow in the sky."

" It has all pretty colours in it."

" It's like half a circle—an arc shape."

T. What did you notice outside as well as the rainbow ?

C. It was raining. The sun was out. When the sun went under a cloud, the rainbow started to fade away. The rain was light and thin.

T. What colours could you see in the rainbow ?

C. I could see yellow and blue, pink and purple colour, red and bluey-green colour.

T. What do you think made the colours in the rainbow ?

C. Water makes colours when the sun shines through it, because sometimes I see colours on the road after it has been raining.

C. I think the sun makes colours.

C. It could be the sun shining through the rainbow, because when it is raining and the sun is not out we don't see a rainbow, and it must have something to do with the sun and the rain together.

C. I think the sun has all different colours in it and the colours are all mixed up. When it shines all the colours together look like a yellow colour. But when the light goes into the raindrops they make the colours come out separately.

The Next Day

Children went outside to see if the sun could make colours in other things—a crystal, a diamond ring, water in a glass bowl, a magnifying glass on paper, a piece of glass.

The children also blew bubbles and they noticed that the same colours they saw in the rainbow were also in the bubbles.

Some Days Later

A prism was brought along and the children played with it. They discussed the things that made light (for example, sun, moon, candle, stars, torch, electric fire), and a book was made in which they recorded their observations and discussions.

Reflected Light

The teacher asked the children to bring mirrors or other shiny things in which they could see themselves—spoons, silver paper, shiny tins, knives, and mirrors of all shapes and sizes. These objects were taken outside. The children passed them round and looked at their reflections.

C. When I look at myself in the spoon I look funny. When I look at myself in the long way of the knife I look fat but the other way I look thin.

C. My face spreads all round the tin.

C. On one side of the spoon I look thin but on the other side I look fat.

The children also had a few flat pieces of tin and they discovered that they looked quite normal in them.

T. Why do we look different when we look in the spoon and the knife and the round tin ?

The children found it difficult to explain this. Quite a few thought the spoon, the knives, and the round tin were made of a different material from that of the flat piece of tin and the mirror, and that was why they looked different. Only a couple of the children suggested that it might be because some things were curved and others flat.

T. Why do you think this ?

C. When I bend this flat piece of tin I look funny, sort of squashed, but when I make it flat I look ordinary.

Refraction of Light

Glass bowls of various shapes and glasses with water in them were put on a table. The children were asked to put straws, skewers, sticks, etc. into the water. The children were then asked to look very carefully at the bowls and the glasses.

C. It looks as if the straw is bent, but it's not, it's really straight.

C. The stick seems to be breaking in half.

The children took the straws and the sticks out to check if they were still straight and found them to be so. But on putting them back into the water they again appeared to be bent.

T. Why do they look different when we put them in water ?

C. I think it is because the jar is round. We really see two parts of the round bowl when we look through. So it might make the straw look as if it is in *two* as well.

C. There might be a shadow in the water.

C. When I look into the jar the straw goes one way, then when it touches the water it goes straight down. The water seems to cut the straw.

C. I think when you look through air, things look all right, but when you put things into water it makes them look different.

A child poured the water out of one bowl and put the straw back in to see if the water made any difference.

C. When you look through the glass the straw looks a bit bent, but the water makes it look even more bent.

Batteries, Wires, and Globes

Suburban School—Grade I

How the Work Began

The children collected batteries, pieces of wire, and torch globes. These were all placed on the science table and the children played with them informally for a few days. Subsequently the teacher and a group of children talked about what the children had discovered.

C. (pointing to battery) That's where the power comes from to make the light.

T. What is inside the battery to make the power ?

C. Electricity.

C. I think radiation is inside.

T. What's radiation ?

C. Well, I'm not really sure, but it is like electricity. It makes a lot of power and it can be dangerous like electricity. I don't know what it looks like. You can get it in different ways.

T. How does this radiation or electricity get inside the batteries ?

C. I think they probably put it in with special gloves and machines.

C. And inside it's a kind of liquid and it makes holes in your pants.

C. The power comes from the battery, up the wire into the globe.

C. The wire must be connected to both the battery and the globe. (Various children then showed how to make light using the batteries, wires, and globes.)

T. Why do you need two wires ? And why do you have to put a wire at each end of the battery ?

C. You have to get power from both ends. If you only touch one end it won't work. (This was demonstrated.)

C. You need equal amounts of current. (Another child had discovered that if he joined two batteries together he made a stronger light.)

C. The two batteries together made more power.

T. Why is it that after some time the battery won't work ?

C. Gradually, all the power that is in the battery runs into the globe, and every time you turn the light on it pulls more power out and the light gets littler and littler.

It would be difficult to decide whether the teacher or the children could gain most from the interchange recorded above. Note how one child confuses two types of batteries and how another child draws on his knowledge of atomic power stations in an attempt to explain how the " radiation " is put into the batteries. Another child puts forward the very thoughtful suggestion that two wires are needed to get equal amounts of current. This is an entirely plausible theory considering the limited experience available, and it should not be dismissed out of hand. It is a possible explanation, in accord with the evidence. Of course there is another possible explanation—that both wires are needed to make a circuit and enable the current to flow—and this is an idea that could be put forward by the teacher, not as a dogmatic statement but as a theory to be kept in mind. By proceeding in this fashion the very essence of science is preserved.

Toys That Move

Beginners—Term II

The children were asked to bring toys that move. A day was selected and the following observations were made by the children during discussion.

Mechanical Dog

T. How do you make yours move ?

C. Wind it up.

T. What makes it move ?

C. Battery.

C. Not a battery. Special wires inside, and when you wind it up the wires make it move its head.

T. What makes the music ?

C. The head moving.

T. Move your head. Does it make music ?

C. No, that's (dog) got something inside it.

Police Car

The car moves about and blows the horn.

T. What does it do ?

C. Makes " Beep, beep, beep."

T. What makes it work ?

C. Battery.

T. How does the battery make it work ?

C. It's got energy in it, goes through the wires to the car.

C. In the battery there's tons of energy, and every time you push the button it sends energy to the car's mind to move it.

C. Electricity goes through the metal things in the car.

Doll in Rocking Chair

It was thought that the children would not accept this as a moving toy. A child pushed it to make it rock.

T. Why does it move ?

C. It's unlevel. You push one end down and lift your hand and it goes up and down, up and down ; the energy does it.

C. It's got energy in it.

T. Is the energy in the chair ?

C. No. It's in the pressing you give it and the weight.

Donkey

The donkey walks and sits and opens its mouth. The children decided it had two movements—(*a*) walking a long distance, (*b*) sitting and braying.

T. What makes the toy work ?

C. Battery.

T. Can you make it walk and sit ?

C. When you push the button up it walks ; down, it sits in the middle and stops.

T. How can the same switch make it do two different things ?

C. Two batteries.

T. The police car had two batteries but only did one thing. No answer.

Constructions

The children were asked to make something that moved. Although they were asked to bring old things from their homes there was no response. The teacher supplied large long blocks, large cotton-reels, small cotton-reels, plastic sticks, and various building kits. The most common model made consisted of wood resting on two axles and their wheels. When the model moved a certain distance, the plank fell off. One child suggested putting holes in the plank. Another child suggested putting string through the holes in the cotton-reels.

Other models were made using plastic sticks pushed through holes in cotton-reels.

Subsequently, most of the children forgot about making moving toys, became side-tracked, and made something entirely different.

The children decided that toys move by batteries, wheels, motors, keys, friction, pulling, and pushing.

This final case study in " Toys That Move " has been included to show that activities do not always proceed along the lines the teacher might wish to follow. When this happens, it is advisable to maintain a flexible attitude. It seems clear that in the case study above the children needed to explore the material more thoroughly before coming to the point where the teacher wished to begin.

Worms, a Tortoise, and Two Fish

In one class of seven-year-olds, the children had three centres of interest—some worms, a tortoise, and two fish. The children wrote about their pets and what happened to them. Extracts from their booklets are given below :

The Way Our Fish Died

> On Wednesday we found our fishes were sick. There names are goldie and big eyes. We put the fish in a special bowl. Goldie died on Wednesday and big eyes died on Friday. The doctor said they had the fungus disease. When we put them into the bowl we put some salt and some green stuff in too. I am very sad for Goldie and big eyes. James and Michael buried Goldie it is very sad for them.

Worm Farm

> To make our worm farm we had to get a glass bowl and some dirt leaves and bark sand and petals and grass. We had to feed the tortoise with some worms and we haven't got many left. We cannot find any more but now after the rain we might be able to find more. The worms had babies we think but we don't know how they came. Some people think they had eggs. The worms mixed the layers and we could see all the tunnels they had made.

Terry the Tortoise

> We have a tortoise in our grade and her name is Terry and we put her in the terrarium we have made.
>
> It went for a 27 foot walk from the back of the class to the heater and it fell 2 foot 8 inches. Its shell is 1 inch in width and about 1 inch in length too.
>
> We put Terry in the fish tank and it seemed to like it. It bumped the side of the fish tank but it did not mind. The terrarium must seem like a jungle to him because he is so small.

Once we tried it on some meat. It ate a bit of it then we tried it on some worms it ate all the worms I think it likes worms best. Karen brought a big tortoise. We put the big tortoise in a big basin with the little one but the big tortoise did not seem to take any notice of it.

Goodbye Terry.

These extracts tell their own story. The last one is particularly interesting, showing as it does not only the activities the children undertook, but also an interest in careful observation and measurement. There is also a tendency to go beyond these and to draw some tentative conclusions. It is significant that the child uses words such as " seem " and " think ". *It is unlikely that the children will ever obtain sufficient evidence from their experiments to justify firm conclusions, and an attitude of caution should be encouraged.*

Rabbits

A report of activities in a second-year class in
a suburban school.

A pair of albino rabbits was installed in the classroom at the commencement of Term III. A hutch was provided with the help of parents.

The rabbits could be observed at any time during the day, and during each afternoon a special half-hour period was spent in the green area of the school-ground. During this period, the rabbits were released for exercise, and the children observed them.

The rabbits obviously enjoyed their freedom and very soon became quite used to the presence of the children. They played about on the grass, and the children were very interested by their movements. This led to discussion of the anatomy of the rabbit—the adaptation of the feet and paws for burrowing, the movement of the ears, the rabbit's peculiar action when running, and the movements of its nose were among the topics discussed. Anatomical features were compared with those of other familiar animals.

The feeding of the rabbits was also a major interest. Many kinds of foods were offered and a list was made of all that proved acceptable. Special favourites were noted.

Added duties and responsibilities in caring for the pets were shared on a roster basis (cleaning the hutch, provision of food and water, and so on). This was a very valuable experience, enabling the children to take responsibility. They enjoyed this.

The interest in the rabbits gave a stimulus to the following subjects :

English :

Oral expression—there was always something of real interest to discuss. Vocabulary was enlarged.

Written expression—diary sentences were collected into a book about " Our Rabbits ".

Reading—the children eagerly sought stories about rabbits, and read them to the class.

Poems—many were found by the children.

Creative Art and Handwork :

Pictures were painted to illustrate the class book.

Health and Hygiene :

The importance of clean living conditions and correct foods was stressed.

Unfortunately, no breeding took place. In spite of the assurance given by the vendor that the pair were buck and doe, they proved to be a pair of does.

At the conclusion of the activities the teacher noted :

" The experiment has been very successful, and in future I will include such an experience each year in my syllabus. The children gained much more than scientific knowledge. Every aspect of their work was stimulated.

" The project presented some physical problems, however, and more suitable accommodation is desirable—preferably an out-door situation for the hutch. The co-operation of parents and other members of staff was willingly given, and is essential to the success of such a venture."

The Wheat Farm

The class viewed a television program entitled " A Wheat Farm ". After writing a story about the farm, the children decided to make their own miniature wheat farms. The children were divided into small groups and they planted wheat in shallow seedling boxes, plastic containers, and saucers containing either soil or cotton-wool. The groups were allowed to put their " wheat farms " anywhere they liked around the room, within reason. The places chosen included the window-sill, under the nature table, on the lockers, on the floor near the lockers, and in a cupboard. The group that chose the cupboard did not wish the rest of the class to see how they had set up their " farm ".

After some time the seeds had started to grow, but there were noticeable variations in the length of the shoots and in the colour. The strongest plants were found to be on the window-sill, while those in the cupboard had made practically no progress. The wheat on the floor had grown, but the shoots were distinctly yellow. A discussion followed these observations and it was decided to see what was actually needed for a plant to grow properly. The children made the following list : dirt, water, air, and sunlight.

Seeds were planted in five containers under the following conditions :

First container : Water, air, sunlight, but no soil.
Second container : Water, air, soil, but no light.
Third container : Air, soil, light, but no water.
Fourth container : Water, soil, light, but no air.
Fifth container : This was the control and the seeds were given water, air, sunlight, and soil.

There is a similarity between the work of this class and the work in a previous section on breathing. In both cases the children used an air-tight jar. The jar was filled almost completely with soil and water and then sealed, to test their hypothesis about the lack of air. In neither case was the children's solution likely to be very satisfactory. However, the results obtained with the other containers did lead the children to conclude that soil, water, light, and air were all necessary.

In the " Case History " described above, the work of the class diverged at this point. However, if the children were interested it would be possible to go further and plant seeds in a variety of soils, including builders' sand, sandy soil, rich loam, and clay. This could then lead to further work with the fertilizers commonly used in home gardens.

INTERACTIONS AND CHANGE: INANIMATE MATERIALS

Introduction

A significant characteristic of human beings is their concern with change—noting change and trying to bring it about, and sometimes even trying to prevent it. Without this characteristic humans would be somewhat less than human. This interest in change can be detected in very young babies ; in older children it is shown by their curiosity and purposeful activity. Education that ignores change will be limited and ineffective. Change is important in children and in education ; it is an indispensable idea in science. Our knowledge about the world comes initially from observing it as it is. By studying the effects of change and by bringing about change we widen our knowledge immeasurably.

In this section of the Guide, many activities have been suggested. It is hoped that these activities will help children to become more aware of changes, more actively interested in bringing them about, and more involved in discussing the interactions between the materials, the various forms of energy, and the outside forces that they work with. The activities selected should be the ones that seem most likely to generate interest ; activities other than the ones suggested here may be equally useful.

It has not been possible to indicate which experiences are most suitable for particular grade levels, since this depends so much on the children, the teacher, and their interests. At different levels children tend to think differently and so, provided their observations and interests are followed up, there is little danger of repetition. Children may undertake work as a class, in groups, or individually, whichever seems best at the time, but it is important that each child should handle and work with the materials as much as possible.

Care should be taken not to force, crowd, or rush through these experiences, otherwise the full impact of an activity may not be felt by the child. In this case the dividend of the experience for the language or art activities that follow may be lost. The dividend for later science experiences may be lost also.

The case studies indicate how activities have been developed in several classes, but, of course, in other classes the lines of development might be different.

Free play with a wide variety of materials is essential in the early stages if children are to develop a confident attack in their later work. Therefore, the methods and the activities that are such a feature of kindergarten education should be extended into the science work of the Beginners and, if necessary, beyond. Work with sand, water, and air often provides a good beginning. The work should be developed informally and extended, using materials children bring from home.

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The following activities should be regarded as suggestions only and should not be followed rigidly.

WORKING WITH WATER

At first, children will play freely and informally with water and a variety of containers and materials—bottles of various shapes and sizes, squeeze bottles, tins, jugs, cups, funnels, sieves, strainers, plastic or rubber tubing, and small objects that will or will not float. Further interest may be stimulated if children add coloured dye to the water.

Further activities may include :

Comparing capacities of different vessels ;

placing stones, sand, sugar, salt, etc. in jars of water ;

pouring from a full container to an empty container and back into the original container.

Floating and Sinking

Include in the collection of equipment articles such as glass and plastic bottles, tins, corks, rubbers, sponges, pieces of cloth, wood, metal, leaves, coins, matchboxes, sheets of paper, plastic, cardboard, plywood, rocks, balls, and marbles. Free handling of these materials will lead naturally to discussion of floating and sinking. The children may find ways to float objects which usually sink, and conversely to sink objects which usually float. For example,

attaching coins to a cork (to float the coins or to sink the cork) ;

pouring water or sand into a floating bottle ;

blowing air through a tube into a sunken bottle ;

comparing a balloon before and after inflation.

Salt water might be compared with fresh water. An egg that sinks in fresh water may float in salt water.

The activities should be carried out in both deep and shallow containers, since it has been found that some children think the depth of the water is important in these activities.

These experiences will help the children to realize that it is not just a matter of weight that determines whether an object will float or sink. Balance scales may be used to enable children to check their ideas about light things and heavy things. Standardized units of many kinds, including rods, blocks, or marbles may be used to measure weight.

After many experiences of the above kind, the children might attempt to predict which objects will float or which will sink. Some children may be able to sort materials on this basis.

Children's observations may be recorded in experience books. Observations such as " When I put a little bit of water in the bottle it still floated, but when I filled it up it sank to the bottom " may be expected from older children.

A bowl of water and a collection of objects could be placed on the science table so that from time to time children could carry out further experiments with floating and sinking.

Absorbing Water

Collect materials such as cardboard, different kinds of paper, blotting-paper, sponges, tinfoil, a variety of cloths (nylon, wool, cotton), rubber, leather, plastic, wood, and chalk. The children may observe and describe what happens when these materials are immersed in water, and, following this, some children might make some attempt at sorting the materials.

Depending on the interests and the abilities of the children, further activities might involve attempts to recover water absorbed by the materials (for example, by wringing) ; comparing the weight before and after immersion, and after recovery of some of the water ; identifying and grouping wet materials according to characteristic smells (for example, wood, leather, cardboard).

Evaporation

Several activities involving evaporation are suggested in the " Discrimination and Classification " section of the Guide. The children may try to discover ways to increase the rate of evaporation—by placing wet materials by the window, by a heater, or in the sun. In some cases they might be able to observe steam rising from the material. Evaporation of water in saucers or glass jars may be treated in the same way, with observations being made over several days.

Water and Heat

There are several simple and interesting investigations that may be undertaken under this heading. With due regard to safety, the teacher may heat water while the children observe and make comments on what they see. They may see what happens when a cold plate and a hot plate are held over the boiling water, or suggest what has happened to the water if the container is allowed to boil dry. Grade II children may realize that the liquid is changed into water vapour (a gas), which, as it condenses, changes into a liquid again.

The children may suggest and then test ways of keeping water hot for as long as possible (for example, by putting the container in the sun ; by wrapping it in paper, wool, or cotton cloth).

Cooling may be investigated in the same way (for example, by placing the container in a cool place, by fanning it, by pouring the liquid).

Further activities may include dissolving sugar, salt, or food dye in water and observing, by sight and by taste, the solution before heating, the residue when it has boiled dry, and the condensed vapour ; heating milk, lemonade, cordial, etc.

Freezing

Activities in freezing might include—

attempting to freeze water in different sections of a refrigerator ;
observing which part of the water freezes first ;
comparing the time taken to make ice-cubes of different sizes ;
comparing the time taken to melt ice-cubes of different sizes ;

changing the rate of melting, for example, by putting salt on the ice-cubes ; by placing the cubes in a draught, in the sun, in tap water, in hot water ; by wrapping the cubes in aluminium foil, in plastic, or in paper ;

freezing (and later melting) milk, lemonade, cordial, etc.

The day's routine may be used to time the activities. For example :

" It took all of reading time for the ice-block to melt."

" It took from recess until lunch-time."

Children will be interested to see whether ice-cubes float on water. If a coloured ice-cube is floated on a glass of clear water, the children may observe how it eventually melts and mixes with the clear water. They can check whether the water level in the glass rises.

The notion of the interchangeability of liquids and solids may be developed during work in this section. As the children carry out the different activities related to heating and freezing water, they may compile books of the sentences they have written describing their experiences, for example, " How We Changed Water ", " Making Ice ", and so on.

Mixing with Water (See " Discrimination and Classification " section)

Various mixing activities may be carried out with powders and crystals and with other liquids mixed with water. The children will observe that some substances dissolve in water, others float on the surface, and others sink to the bottom.

The water-mixing activities may be associated with some study of evaporation of the different mixtures. This may lead to further ways of grouping the powders and the liquids, for example, those that evaporate quickly, those that evaporate slowly ; those that we can recover (" get back again ").

Interesting comparisons may be made between water and turpentine. Children should note what happens to a comb, sand, sugar, or oil paint put into water, and then what happens to these things if they are put into turpentine.

Water Pressure

Children may pour water into tins with holes punched at various levels and note the difference in the streams of water coming from the lower and the higher holes. No formal explanations are needed. Children should be left to experiment, observe, and comment. They may also observe water spurting from a hose and see how, with more pressure, the water goes higher into the air or gouges deeper holes into the ground.

Siphoning

Children may experiment with rubber or plastic tubing, drawing water from one vessel to another and emptying and filling containers.

Water and Plants

As will be seen in the " Life " section of this Guide, children may try germinating seeds with and without water, and later compare the growth of established plants with and without water.

Water and Sand

Children may experiment with wet sand and dry sand by—

pouring ;

filling and emptying a variety of containers ;

using different proportions of water ;

watching the behaviour of water with dry sand and sand with different degrees of wetness and also noting how much water can be poured into tins of wet sand and tins of dry sand ;

using tins of various shapes and sizes to mould wet sand, and then leaving them to see what happens ;

building with wet sand and with dry sand.

Older children may compare the weight of two equal quantities of sand, one mixed with water and the other dry.

Link with Social Studies

Grade II children may be interested to learn where the water in our taps comes from, and to compare this supply with the way some country people obtain water from tanks, dams, and windmills connected to underground bores. They may appreciate, eventually, that the availability of water depends on weather.

WORKING WITH AIR

Balloons

Activities with balloons are helpful in introducing experiences with air. During their play children may note—

the " feel " of the air compressed inside the swelling balloon ;

the rush of the air out of the neck of the balloon.

They may use the jet of released air to drive boats across a dish of water. The " boats " may be matchboxes with or without paper sails.

If air from a balloon is released under water, the bubbles can be seen rising to the surface. Other activities with air-bubbles, such as filling bottles under water and blowing bubbles with soap and water mixtures, may follow.

Children may be interested in discussing whether or not air is heavy. They often think that an inflated ball is lighter than the same ball which has not been inflated. Let them suggest how they could find out. If a basket-ball bladder is inflated and weighed on kitchen scales, the air can then be released and a measurable decrease in weight detected.

Bicycle Pumps and Toys

Encourage children to bring bicycle pumps and suitable toys. These should be left on the science table for informal investigations.

The pump could be dismantled by children, who may then attempt to explain how it works. As they play, children will probably comment on the difficulty of depressing the handle while the hole in the base of the pump is covered. They may also attempt to inflate a bicycle tyre, although some of them are unlikely to succeed.

Some dolls which emit sounds when squeezed could be examined and discussed.

Whistles and toy musical instruments should also be investigated.

Blowing Bubbles

Bubble pipes, bubble rings, and straws are useful for blowing bubbles. Different mixtures of soapy water, detergent, and patent bubble-producing liquids could be compared. Children may note that the bubbles seem to float on air currents. This could lead them to collect or list other materials that are sometimes airborne—dandelion seed, feathers, tissue-papers, smoke.

Spirit-levels and Transparent Tubing

If a spirit-level is available it should be left on the science table for examination and discussion. If transparent plastic tubing is available, children may attempt to trap air in it when both ends are submerged under water and most of the air is allowed to escape. The air-bubble that remains can be moved about and likened to the bubble in the spirit-level.

Air and Water

As an extension of early water-play activities, the following activities may be undertaken :

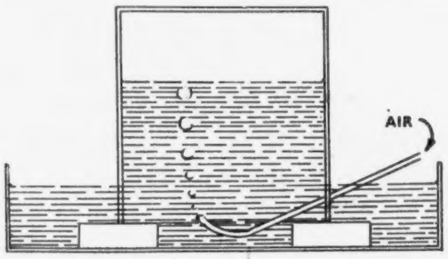
Filling and emptying bottles under water ;

putting a piece of crumpled paper in a bottle, inverting the bottle, and lowering it mouth down into water ; the paper should remain dry, a fact that often provokes discussion ;

pushing an empty jar down over a cork floating on water, and noting what happens ;

attempting to fill bottles through a funnel placed in the neck, around which plasticine or clay is placed as a seal ;

expelling a breath through a tube into an inverted jar of water standing in a dish of water (see below) ;



filling a straw with water and then holding it with a finger over the upper end ;

making a small hole in the press-on lid of a tin, filling the tin with water, replacing the lid tightly, and up-ending the tin ; the water is not likely to run out.

In each case the aim at this level is to provoke discussion and speculation rather than to provide answers.

Dry Soil, Bricks, and Sponges

Children may be interested to note and discuss what happens when a dry brick or a plant pot filled with dry soil is placed in a bucket of water. Similarly, a sponge could be submerged in water and squeezed so that air is expelled.

Breathing

Work undertaken could be an extension of the activities set out above under " Air and Water ".

Children may put their hands on their own chests to feel the expansion and the contraction as they breathe. With lengths of string, they may measure the degree of expansion of a number of children. Children from other classes higher up the school could also be measured, and the results obtained organized to make a chart.

This work could be linked with health and a discussion of the desirability of fresh air. Some children are interested in skin diving and may wish to discuss how skin divers and spacemen obtain air.

Fans, Bellows, Accordions, and Vacuum Cleaners

Fans, bellows, accordions, and vacuum cleaners, if available for examination, could all prove useful in promoting discussion.

Candles

An inverted jar may be placed over a burning candle. This could lead to discussion as to why the candle goes out. Inverted jars of different sizes could then be placed over candles and comparisons made. It should be possible for the children to time the periods taken for the candles to be extinguished. Let them suggest methods of timing. They may suggest counting or tapping rhythmically.

Further discussion is likely to be aroused if a burning candle is stuck to the bottom of a dish of water and then covered with a jar. The water level in the jar rises. There is no need to supply explanations. Encourage discussion and note the types of answers children give.

No matter what activities are undertaken, they should be seen as offering opportunities to develop language work—both oral and written ; art activities can also follow, and these provide other ways of enlarging the original experience.

WORKING WITH HEAT

Suitable heat sources are the small cubes of solid fuel available at most hardware stores, the heat of the sun, an electric fry-pan, and candles. " Hardiflex " or some other heat-resistant material should be used to protect school furniture where necessary. An old piece of blanket or rug is useful to smother flame in an emergency, but such a situation should not occur if precautions are taken. The teacher should use her discretion in deciding which heating activities are suitable for a particular grade. Older children in the infant school are quite capable of working with candles and other safe heat sources. Where an electric fry-pan is being used, however, the teacher should do the work, following children's suggestions. This work should be used to develop important safety concepts in the children.

Only small quantities of the materials are necessary. When observing change, and where it is practicable, the children should observe carefully, using the appropriate senses, and then discuss what they have noted. As a result of their observations, children may make groupings as suggested in the section " Discrimination and Classification ", for example, things that melt, things that change colour, things that give off some smell when heated.

Suitable Materials

Some suitable materials are—

crayons
butter
sugar
dough
rubber
candles
chocolate
salt
putty
nylon
ice-cubes
water
flour
clay
jelly.

Foods such as meat and vegetables (including onions), as indicated in the case study " Cooking ", are also suitable materials to experiment with. Tin lids make suitable containers for the materials being examined.

Melting and Solidification

Cubes of ice taken from a refrigerator soon melt. Children might experiment to make them melt more quickly or more slowly. They might suggest that blowing on them will cause them to melt more slowly, or that covering them with a cloth or soil will cause them to melt quickly. Crushed ice or blocks of ice of different shapes can be given the various treatments suggested.

In hot weather, if pieces of chocolate, butter, and so on are put in a warm place they will melt. Overnight, or in a refrigerator, they solidify. In this way the beginnings of the idea of interchangeability between the solid state and the liquid state are built up.

This activity would probably lead to attempts being made to melt other materials, such as sugar, using the heat of candles or solid fuel tablets.

Candles

Work with candles was referred to earlier. It might be extended to an investigation of the time taken for a candle to burn away, and this in turn could lead to comparisons being made of the rate of burning of candles of different sizes. Collect birthday candles, tall thick candles, tall thin candles, and short fat candles for this work, and encourage the children to forecast which candle will be the first to burn away.

Children are often interested in the shapes they can make with the melting wax of the candle and in the shapes that are formed when the molten wax is allowed to drip into a glass of cold water. This may lead them to experiment using coloured crayons, perhaps making patterns by dripping the colours over a piece of paper.

Liquids and Heat

Evaporation of water in a fish-tank over a period of hot days can lead to comparisons of the rate of evaporation of a number of liquids. These should be left in a warm place for some days. Use small quantities placed in saucers. Suitable liquids might include—

milk
coffee
powder colour
water
honey
egg (white or yolk)
hand lotion
golden syrup
coloured soft drink
detergent.

Encourage the children to forecast which liquid will disappear first and, in general, to describe and discuss what they observe. They may also speculate on where the disappearing liquids have " gone ".

Heating Mixtures

Where children have engaged in mixing materials with water, they may go on to discover what happens when some of the mixtures are heated. Suitable mixtures might include—

sugar and water (strong solution)
flour and water
salt and water
jelly crystals and water.

Burning Materials

If experiments can be safely arranged, children may be interested in observing changes that take place when various materials are burnt in candle flames or similar heat sources. Only very small snippets of material are needed, and these can often be impaled on straightened-out paper-fasteners. Suitable materials include—

papers
woollen cloth
plastic
meat
putty
cardboard
silk
rubber
bread
clay
cotton cloth
nylon
wood
plasticine
fruit.

The children should be encouraged to comment on the flames, the smells, and the remains. Materials could be sorted on the basis of the evidence obtained.

Safety rules should be discussed as well as ways of extinguishing fires. Children may note that fanning or blowing may speed up the burning process, while cutting off the air supply in some way will stop it. Children may attempt to find some way of measuring the time a piece of material takes to burn.

These activities could be related to work in social studies (for example, the work of the fireman) as well as to general language activities.

Cooking

The likely trend of activities has already been described in a case study (see page 46). Cooking could develop naturally from the mixing and the heating activities suggested above.

OTHER INTERACTIONS—HOUSEHOLD MATERIALS

The case studies " The Effect of Vinegar on Various Substances " and " Cooking " (see pages 43 and 46) indicate how certain materials may be used. Other useful materials include—

- lemon juice
- milk-bottle tops
- salt
- fruit saline
- sugar

as well as any other materials that may be brought along. The list provided for the unit " Household Chemicals and Change " in Part C, *Branching Out*, may prove useful. Only small quantities of the materials are necessary.

Liquids and Papers

Children may place a drop of household machine oil on a piece of paper. The paper should be left for a few moments and then held up to the light. Oils and other liquids could then be tried on a variety of papers, including tissue-paper, brown paper, grease-proof paper, and lunch-wrap paper, so that comparisions can be made.

Metals, Air, and Liquids—Rust

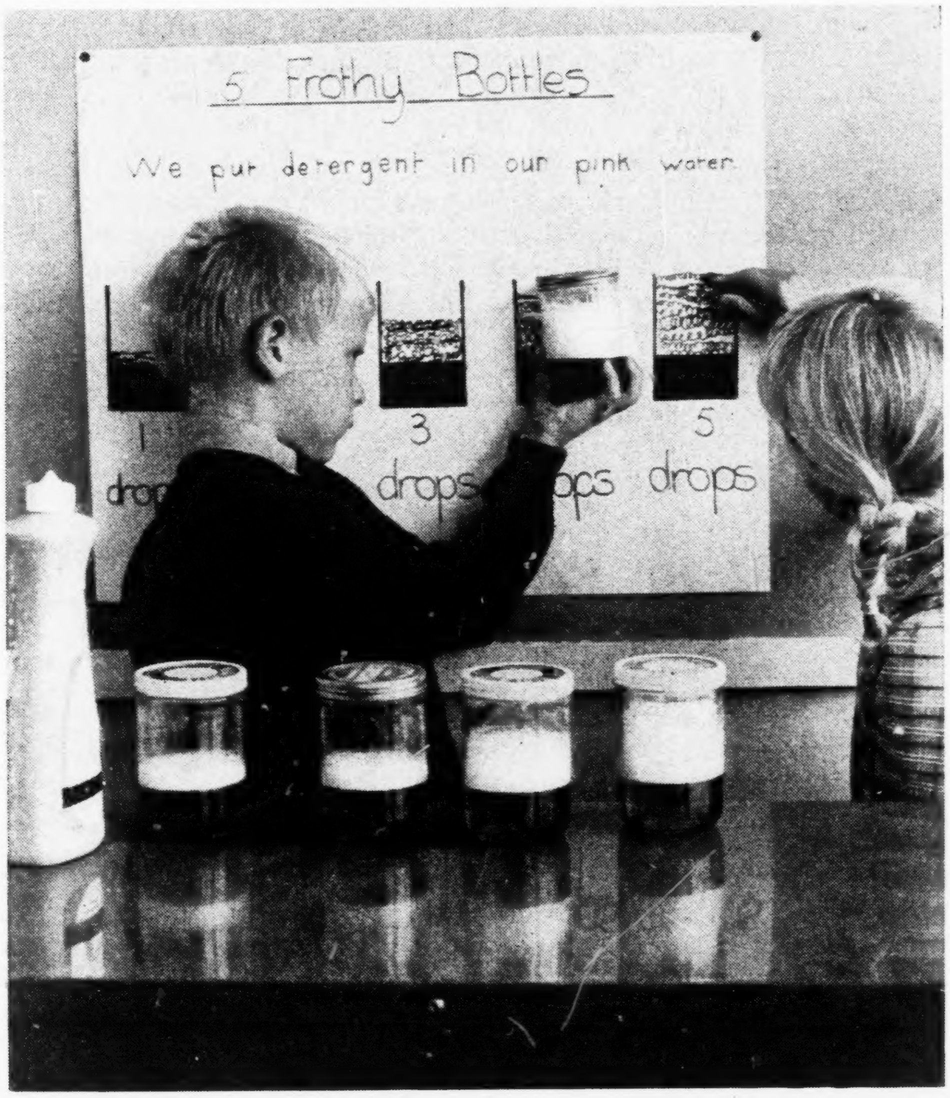
Children may observe and describe the interaction between steel wool, water, and air. Children could rub the rust off onto their fingers. Pieces of galvanized iron could also be used. The children should note what happens when the surface of the coated iron is scratched deeply.

Samples of materials such as plastic, brass, copper, and tin could also be used in conjunction with a variety of liquids. Such things as a marble, a coin, a nail, a tack, a paper-clip, and a comb could be placed in jars of water for observation at regular intervals, and from time to time they should be compared with those exposed to the air.

Sorting of the materials may be done on the basis of those that become rusty and those that do not.

Soap, Detergent, and Water

Informal work may involve shaking different combinations in jars, and then measuring the froth produced and the time it takes to disappear.



Children may try cleaning surfaces with plain water and with the mixtures. In one class, children heard of detergent being used to break up a great quantity of oil jettisoned from a wrecked tanker. This led them to use oil, water, and detergent to see if they could do likewise.

Iodine and Food

If children put a drop of iodine on a piece of household starch they will note that a very dark blue-black colour is produced. They may then go on to test foods, including bread and potato, for a similar reaction.

Sand and Cement

If, as part of their social studies work, children go on an excursion to watch building and concreting activities, they may become interested in trying to make their own concrete. If jars of cement, sand, and gravel or aggregate are collected, this could be done using proportions decided upon by the children themselves.

Paper cups or matchboxes make suitable containers for the concrete, or it could be moulded into various shapes as part of the children's activities.

Change and Decay in Food

Pieces of bread or fruit may be kept for a time in an air-tight tin, exposed to the air, or buried in the ground. During discussion the children could be encouraged to predict what might happen and then to observe, over a period of time, the changes that occur (preferably with the help of a lens).

Later, comparisons could be made with pieces of food kept over a period of time in a refrigerator.

Making Butter

Children may be interested in separating cream from milk and then beating the cream to produce butter. This activity could also be linked with social studies work on food and may lead to observation and timing of other food changes associated with beating, including the making of meringues or scrambled eggs. Timing could be done with a burning candle, an egg-timer, or by counting.

INTERACTIONS AND CHANGE : ENERGY AND FORCES

Introduction

No attempt need be made to define the concepts involving interactions and change with energy and forces with children of infant school age, but it is possible to develop some ideas about them through appropriate experiences. The general notions of interaction and change can provide teachers with a useful starting-point for this work.

Many changes involve the application of external forces or the introduction of energy into a system. In the present context a " system " might be a toy operated by clock-work, a piece of lump sugar composed of molecules arranged in certain patterns, or even a book resting on a table. In the case of the toy, energy is introduced when the spring is wound up ; in the case of the sugar, energy is introduced when heat is applied ; in the case of the book, its position and movements are dependent on the forces operating on it—first, gravity, secondly, the upward force exerted by the table, and thirdly, the frictional forces that may prevent the book moving if the table is tilted. In each case change may be brought about by altering some feature of the situation.

Energy

Energy is often manifested as motion, and this is a useful way to introduce the idea.

Activities and discussion on motion can be grouped around such questions as :

What things are moving ?
What makes things move ?
How can we use moving things ?
What are some of the things that moving things can do ?

By the end of Grade II we would expect that the children would understand that things do not normally move on their own, and that a variety of ways can be found to make them move. This should also have brought about some development in manipulative skill. But the most important thing is to gain wide experience in this field.

The teaching methods suggested are the same as those in the other sections. It is important that children should have as much personal experience as possible, and one way to ensure this is to have material available in some part of the room for the children to use during their " free " time. The children should be encouraged to talk and write about what they are doing. The observations and the conclusions made by children will be simple, and no attempt should be made to teach abstractions or ideas that are not in accord with the experience the children have had.

Not all of the desirable experiences with energy fit obviously into the " motion " framework. Some activities with heat and light, which are also forms of energy, are included. There is no need to link forms of energy for the children. In fact, if the word " energy " is used at all it would be in sentences such as :

> " You are doing a lot of work today, you must have a lot of energy."
>
> " I give this car energy when I wind it up, because then it can move."

Forces

Sometimes the relationship between one body and another is expressed in terms of the forces operating. A force may be regarded as a push or a pull, or as some external agency that can cause an object to move or to remain at rest. Forces with which infant school children should become acquainted in an informal way are muscular forces, magnetic forces, the wind, elastic forces (rubber bands), gravitational forces (weight), and frictional forces.

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The following activities should be regarded as suggestions only and should not be followed rigidly.

WORKING WITH SOUNDS

The activities children undertake will be closely associated with discrimination and classification work. (See the appropriate section of the Guide for further information.)

Activities develop out of the collections children make, which may include—

whistles
vibrating rulers
mouth-organs
xylophones
recorders
rubber bands
guitars
chime-bars
tuning-forks
drums
stretched rubber bands
tambourines

percussion and Carl Orff instruments and various odds and ends that are brought along.

The activities might include—

sorting the materials according to the way the sound is produced ;
noting whether vibrations are produced ;
making instruments, for example, a rubber-band guitar, a milk-straw whistle, a bottle xylophone, drums made out of tins and stretched balloons, " sound " sticks similar to those used by aborigines.

WORKING WITH HEAT

Moving things sometimes produce heat that can be detected. This occurs in activities such as bending wire, rubbing the hands or two pieces of wood together in the way aborigines do when making fire, drilling wood with a steel bit, sawing wood, and filing metal or wood.

On the other hand heat, or the lack of it, may be responsible for changes. Examples are the evaporation of moisture from the asphalt in the playground after a shower of rain one warm day ; many of the matter changes associated with changes of state that are mentioned in another section of this Guide ; and changes in the behaviour or the growth of certain animals and plants.

Children may investigate the types of fuel that are in common use, and this activity could be linked with work in social studies. Fuels listed would probably include—

electricity
gas
oil
briquettes
black coal
brown coal.

Further links with social studies will occur if insulation of houses and of people (by means of warm clothing) is investigated.

WORKING WITH LIGHT

The activities that develop will depend on the material available. The following list may prove useful :

Pieces of coloured cellophane, coloured glass, or clear plastic ;

magnifying glasses ;

toy binoculars or a toy telescope ;

a prism or other piece of cut glass (sometimes old cut-glass inkwells can be obtained, and these are quite suitable) ;

curved reflecting surfaces (spoons, an old curved electric kettle, or other plated article) ;

a torch ;

- scraps of coloured material ;
- a kaleidoscope ;
- mirrors ;
- small coloured objects ;
- buttons or number rods (with these and two mirrors, children can make their own kaleidoscopes) ;
- candles ;
- torch globes ;
- materials for making " rainbows "—oil, liquid soap, or bubble-blowing kits.

For the younger Beginners, the collection of materials of this nature may in itself prove satisfying. Frequently, their activities may be random and with seemingly little point, at least to adult eyes. Older Beginners may spend brief periods working in small groups, sorting materials, and grading them. They may work busily if given some direction, for example, " See what you can find out about some of the things on the glass table (or ' mirror table ' or ' rainbow table '—whichever name seems to be most suitable in the situation as it develops)."

The list of materials given above may possibly suggest a number of activities. The suggestions given below are included merely to amplify these, and should not be thought of as " lessons ".

Discussion of Sources

Children may be interested in discussing sources of light. If the sun is being discussed, warn children of the danger of looking at the sun. Even a brief moment spent looking directly at the sun can result in permanent scarring of the retina.

Some children think that the moon is a direct source of light—that moon " shine " is the same as sunshine. This could also be discussed. Other sources of light include—

- stars
- fluorescent tubes
- torches
- street lights
- candles
- lightning
- lamps
- matches.

The discussion could be linked with social studies : " How We Get Light in Our Homes " and " Ways of Lighting Houses in Past Times ".

Coloured Light

If coloured cellophane is available a number of activities are possible :

- Looking at other children through different colours and noting changes in the colours of clothing ;
- drawing a green house and looking at it through green cellophane and then through red cellophane ;
- shining torches through coloured papers and blending the coloured rays.

Encourage the children to sum up their findings in both their oral and their written language work. These activities may also be used as stimulus material for art work using coloured papers, transparent or otherwise.

Rainbows

Making rainbows with a hose. Choose a sunny day when a sprinkler is working in the school garden. Work should be undertaken either early in the morning or late in the afternoon. The sun must be behind the children and the drops of water in front. Do not arrange things in this fashion. Let children discover it for themselves. The waterdrops break up the sunlight into its colours. In the middle school the children may experiment to observe the opposite effect, where a number of colours combine to produce white ; but in the infant school it is perhaps sufficient to observe the rainbow and note the relationships between sun, viewers, and waterdrops. The children may note other rainbow effects, such as when oil is seen on a wet roadway, and they can attempt to produce similar effects in the classroom with liquid soap and bubble pipes. These activities could then become the subject for language work.

Kaleidoscopes

A toy kaleidoscope may help to generate interest and would be a worth-while addition to any infant school science " kit ". Unfortunately, kaleidoscopes are difficult to take apart and harder to put back again. Children can observe similar effects with pocket mirrors. A number of coloured objects can be placed in front of two mirrors taped together. When the angle between the mirrors is altered, the reflection changes in a most intriguing fashion. The coloured objects or pieces of paper, buttons, rods, etc. may also be placed on a sheet of plain glass raised on matchboxes or books to allow light to enter from below. Tape three mirrors together to form a long, prism shape and place this over the objects. Viewed from the top, the effect is similar to that obtained with a kaleidoscope.

Older children may be able to paint glass with aluminium or silver paint to make mirrors for themselves. This would be an activity for older children working in a small group and closely supervised by the teacher. This work may lead to an investigation of the reflective properties of other materials, such as aluminium and stainless-steel strips, that children collect. In fact, if the use of mirrors is inadvisable for reasons of safety, pieces of shiny, stainless-steel strip can be obtained from hardware stores and are a satisfactory substitute. Chain stores also sell circular double-sided shaving mirrors of stainless steel for about 30 cents, and these may be of use.

Reflections

Work with mirrors could lead to work on reflections. Many young children find it difficult to explain how a patch of light comes to be on the wall or the ceiling. Their interest can be aroused to a high pitch and their own ideas probed by questions and by activities involving trays or jars of water on window-ledges in sunlight, so that light is reflected on to the ceiling. Outside, mirrors can be used to reflect sunlight and create dancing patches of light on walls.

Children may discuss and collect other reflecting surfaces, including some that are curved and produce distortion, such as spoons and the shiny steel strip mentioned above.

Light Globes and Candle Flames

Some children in Grade II might be able to compare the different properties of light emitted from various sources. In addition to ordinary candles, they might make their own. For this they should have suitable absorbent strong string, kitchen fat, oils, and other materials they themselves suggest. For reasons of safety, activities of this nature should be closely supervised by the teacher. They could also be used to introduce a discussion on the danger of burns and hot liquids. The differences in the light given out by pearl globes, clear globes, and fluorescent lights might also be noted and discussed. Children may also be interested in the different colours of street lamps and neon signs.

Pencils in Jars of Water

Let children experiment and note how a pencil in a glass of water may appear to be thicker or fore-shortened, depending on the angle at which it is viewed. At this level, there should be no explanations of this phenomenon.

Eyes of Pets and People

A suggestion that children might find out as much as possible about eyes and record the information in a book may encourage the children to observe closely, to compare, and, at times, to draw simple inferences. Sentences such as the following are likely to be written :

> " The white mouse's eyes are like little beads."
>
> " The fish never closes his eyes. His eyes are on the sides of his head and he can see behind him."

Shadows

Some children are not aware that a shadow is caused by an interruption of the rays of light. Work with a shadow theatre, observations of shadows at various times of day, and the making of simple shadow puppets for use at home could all provide an appropriate background of experience in this area.

Blowing Bubbles

Bubble-blowing activities may lead to discoveries being made about light, as the following sentences from a class experience book show :

> " The bubbles are shiny and the light makes a window."
>
> " I can see a rainbow in the bubble when it floats in the air."
>
> " The bubbles shine brightly when they fly gently up in the air and they make window shapes. The window shapes are square boxes."

WORKING WITH MAGNETS AND BATTERIES

Magnets

Materials

It is desirable to have a number of different types of magnets—bar, horseshoe, and U-shaped. The magnets children bring along are often fairly weak and they should be supplemented by a pair of strong alloy magnets that can be obtained from science equipment storehouses. Powerful circular magnets can sometimes be obtained from radio repairers who get them from old loud-speakers.

In addition to the magnets, other materials should be on hand, such as—

coins
forks
steel wool
hair-clips
paper-clips
ball-point pens
corks
plastic
pencils
shells
pins
aluminium
knives
wool
nails
tins.

Sometimes ironstone gravel from the school grounds will adhere to the magnets and, if so, it should be added to the class collection of materials.

Activities

In the early stages, children should be encouraged to work informally with the materials and to make their own discoveries, about which they should talk freely. A number of activities that children might undertake are as follows :

Testing materials on the science table, around the classroom, and around the school to find out which are attracted to the magnets and which are not. This could be associated with classification work.

Testing to discover which is the most powerful part of the magnet. This can be done by noting the number of pins that can be held at the end, near the end, and near the middle of the magnet.

Testing to discover whether magnets attract through other materials : paper, cardboard, pieces of wood (thick and thin), sheets of metal, plastic. In one school iron filings were mixed with sawdust and later separated with a magnet. In another class, pins were placed in the fish-tank and later removed. Iron filings were placed in a jar of water and, when a magnet was lowered into the jar, children watched the filings rising through the water to the magnet.

Making small cork or balsa-wood boats with a small nail or some other piece of iron attached. These boats can be navigated around a shallow dish of water, holding a magnet either above or below the dish.

Observing the behaviour of two magnets in close proximity to each other.

Attempting to magnetize iron or steel objects by stroking them in one direction with a magnet.

Measuring the distance through which magnetic forces can be seen to operate on objects such as a compass. Children should be encouraged to suggest their own units of measurement.

Batteries

Materials—

Dry cells from torches.

" Double " batteries of the type used in bicycle lamps.

Pieces of wire of different types. Some at least should be plastic-covered.

An assortment of globes (mainly torch globes). Try to ensure that some of the globes have broken filaments.

It is possible to buy torch globe sockets that can be tacked to pieces of wood, but if these are not available, wooden spring-loaded clothes-pegs can be used to clamp globes and wires together.

A collection of materials to be used in making tests of conductivity. These would include pins, nails, hair-clips, matches, paper-clips, pieces of plastic.

Toy electric motors. These are not essential, but many children may already have them or they can be purchased from toy shops.

Old electric bells or buzzers, electric motors from construction kits, plastic cog-wheels, pulleys and belts, switches. Once again these are not essential, but if children collect these or similar odds and ends, they can be put to good use.

Activities

The case study " Batteries, Wires, and Globes " (see page 50) suggests a number of activities. Other activities are suggested below :

Taking torches apart and attempting to describe how they work.

Making torch globes light up.

Making circuits that incorporate more than one globe and dry cell.

Testing materials to see if they conduct electricity.

Using toy electric motors to spin cardboard discs.

Cutting open torch batteries to see what is inside.

Making models (animals made from cardboard boxes or dolls' houses) that can be illuminated in some way. In one class a girl was seen making a one-eyed monster from a shoe-box, with four pegs as legs and a circular disc of cardboard as a head, in the centre of which a single " eye " glowed.

Discussion and the making of experience books should be encouraged in order to help children organize the discoveries they have made.

It should be made clear to children that, although it is quite safe to experiment with batteries, under no circumstances should mains electricity be tampered with.

Opportunities should be taken to link work in science with social studies work on the uses and sources of electricity in the home and the community generally.

WORKING WITH CONSTRUCTIONS AND TOYS

Before attempting activities in this section, it would be advisable to read the relevant case study, "Toys That Move" (see page 51).

A Collection of Moving Toys

The children should be encouraged to make a collection of moving toys. Useful work can be undertaken even if the toys are kept at school for only one or two days. Children should demonstrate the working of the toys and discuss the causes of movement. Some toys must be pushed or pulled, some wound up; some are battery operated. In friction-drive toys, energy is stored by making the fly-wheel inside spin rapidly. The toy is held firmly, made to run short distances while being held, and then let go. If broken toys are available, the mechanisms should be investigated and discussed.

Later, children may be interested in comparing the distance a toy such as a train or a truck will cover with and without a load, or when made to travel up or down slopes of different gradients.

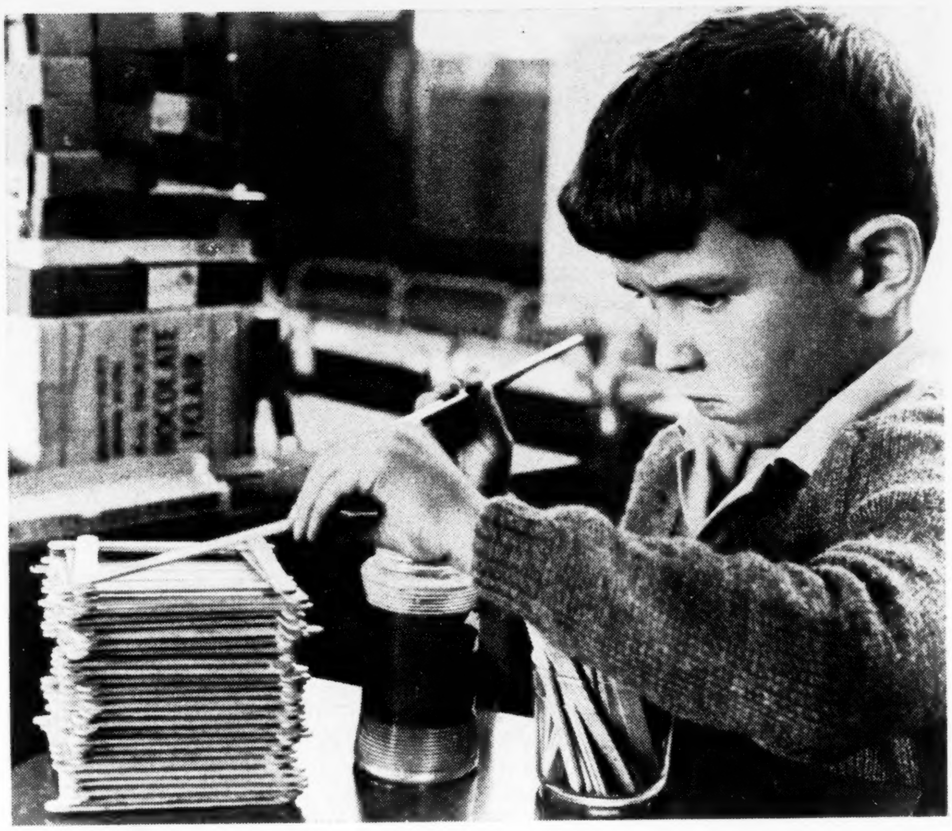
Distances covered should be measured and perhaps timed, taking into consideration the stage of development of applied number work in the class.

Construction Materials

Any of the sets of plastic construction materials currently available are useful, particularly if used in conjunction with sets of wheels. Waste material is equally effective, cheaper, and allows for more creative development. Wood scraps, nails, steel off-cuts with holes, nuts and bolts, wheels and cogs, cotton-reels, wooden and metal rods, rubber bands, and pieces of elastic are also useful.

Younger children may enjoy activities such as attaching wheels to a solid piece of wood and pushing it around ; older children will probably make more complicated structures, perhaps using small electric motors to make them move.

As a result of their activities, children should discover incidentally that wheels, axles, and pulleys help to move heavy loads. When some relatively heavy object such as an old desk or a heavy tin or box has to be lifted up steps, the usefulness of a ramp may also become apparent. Children will no doubt discover that loads can be pushed or pulled. Depending on the circumstances, a push may be more advantageous than a pull.



References should be made to various articles that are used in daily life and that have wheels—for example, bicycles, prams, billy-carts, wheelbarrows, cars, and tractors.

If children are studying transport in social studies, they should note the vehicles that use wheels, the number of wheels they have, and the heavy loads that can be transported on wheels. They may also discuss sledges, sailing boats, and rowing boats, none of which use wheels.

Clocks and Locks

Old clocks and locks that can be taken apart are useful. Some clocks are wound up, some run off mains electricity, some have batteries. In all cases something must be supplied to make the hands move. This work could lead to an investigation of other ways of telling time—water-clocks, candles burning, and sun-dials.

With locks, the relationship between a particular lock and its key should be examined.

Living Things

As part of their work with living things, children should observe and discuss the movements of caterpillars, grasshoppers, ants, spiders, birds, mice, and other animals. Their movements should be compared with the movements of toys and clocks, leading towards the idea that food is required by the animals and by human beings to enable them to move.

The Wind and the Air

From time to time children may have experiences leading towards the idea that wind or air may act as a force. Their activities might include the following :

Making paper windmills ;

making and flying kites ;

blowing paper or matchbox boats across a bowl of water, or moving them by releasing air from an inflated balloon ;

making parachutes from weighted handkerchiefs ;

making paper aeroplanes and darts ;

watching papers, grass, flags, trees, and dust being blown about on windy days.

These experiences could be linked with stories and poems about the wind. All of this work could provide motivation for the making of experience books containing the children's own stories, poems, and pictures.

Rubber Bands

Model aeroplanes and boats powered by twisted rubber bands should be made and used. When a child winds the propeller of a rubber-powered aeroplane, the energy involved in winding is stored in the rubber band as it is twisted and tightened. This energy is then available to turn the propeller when the plane is released.

Weights (Gravitational Forces)

Children can use clock-face kitchen scales for weighing, or they may make their own weighing devices from rubber bands. In this case, weight is measured by noting the extension of the bands supporting the object that is being pulled down by gravity.

Children may note that when anything falls it always falls towards the earth. They may be intrigued by questions such as :

Why does it go down ?

Does anything fall up ?

Children may also discuss what it is like to go upstairs and downstairs, uphill and downhill. They may also think about the way rain falls, the way balls fall, and the great effort that must be needed to move a train or get a rocket into space.

Balances and See-saws

In an ordinary balance, the weight of the object on one side equals the weight of the object on the other side, when the balance arm is level. In a see-saw, a small weight on one side may provide a balance for a greater weight on the other side, depending on their relative positions along the see-saw.

The work in science could be combined with the work in mathematics, and use made of the see-saw in the playground and the balances in the school.

Friction

Some introduction to friction forces may occur when heavy objects are moved across the classroom. It might be possible to make a number of " slides " out of wood, laminex, sand-paper, linoleum, and pieces of material such as tweed and silk. These could be propped up on the science table or in a corner of the room and blocks of wood or weighted matchboxes slid down them. The effect of oiling the school wheelbarrow or the wheels of bicycles could also provide starting points for discussion.

Marbles, Footballs, and Basket-balls

These do not move without some outside force being applied. Children might try rolling objects down slopes, watching them increase in speed, and noting how far they will continue to roll. Toy cars could be rolled down sloping boards and the distances they travel noted.

Motor-cars and Aeroplanes

Excursions to garages to see the work done there by mechanics and petrol attendants could be used to initiate discussion on what is involved in keeping cars and planes moving. It is not necessary for facts to be taught, and it is desirable that children should attempt to explain what they have observed in their own way.

Machines at Home

Children may discuss how machines are used to make work easier. They could compare the effort required to do a certain task manually with the effort required when a machine is used. Machines that might be considered are—

mixer
paint-sprayer
refrigerator
polisher
fan
vacuum cleaner
lawn-mower
drill
sander
hair-clippers.

Simpler devices might include—

hammer
screwdriver
spanner
wheelbarrow.

Opportunities should be found to stress dangers which may be encountered in the handling of these and other machines.

Muscles

Children should understand that through their own efforts they can bring about change, using their own muscles. They should discover from direct experience that digging in the garden, hammering, pulling out nails, building huts in the school-ground, shifting heavy objects, and throwing and kicking a ball all involve the application of energy and the use of various body muscles.

INTERACTIONS AND CHANGE: LIFE

Introduction

To a young child living things may be only vaguely distinguished from those that are non-living. In fact, the matter is one that few young children ever consider. In one class five-year-olds answered questions about life in the following ways :

How do you tell that something is alive?

It grows.

You can feed it.

It walks off when you touch it.

You can tell because of its colour.

Is a cloud alive ?

Yes, because it moves.

Yes, because it makes rain.

Is a bicycle alive ?

No, because it needs someone to make it go.

Is the sun alive ?

Yes, because it shines.

Yes, because it is hot.

Yes, because it is bright.

Yes, because it is made of fire.

Is a clock alive ?

Yes, because it ticks.

These answers give some inkling of child logic and of possible starting points for investigations. Characteristically, young children choose one aspect in deciding whether or not a thing is alive. They will often say that the living thing is alive because it has a heart-beat or because it breathes, or they refer to its colours. Often, they have no coherent picture of the characteristic features of life and, apparently, little idea of what constitutes an adequate justification for the decisions they make.

However, as children grow older they do begin to show more understanding, principally as a result of their wider experience. The conversation reported below illustrates these points. The children were in their second year at school. During the third term, the teacher began by asking the children whether they thought a tree was alive. The children said it was. They were then asked if they thought an animal was alive. Once again, the children said that it was.

However, when the teacher asked the children if they thought the sun and the clouds were alive, confusion and argument arose and the children were divided as to their answers. The discussion continued :

T. How do you know if something is alive ?

C. It moves.

C. If it is alive, if it doesn't have any leaves, then it is dead. If the leaves are green, then the tree is alive.

C. You can tell by the colour of things if they are alive or dead. When things die, they start to lose their colour. When flowers die, they begin to lose their colour. When my worms died, they dried up and went a dark-brown colour.

T. How do we know if a person or an animal is alive ?

C. With a person, you can hear them breathing. You can feel their heart beating and you can hear them talking. If they are dead their skin rots away but their bones stay. That's a skeleton.

C. If a person is alive they move.

C. They keep soft skin on their bodies. It doesn't rot away.

C. When people are alive if you tickle them on the toes they laugh.

C. Live people's eyes open and shut, but when they are dead they don't open.

T. Is a car alive ?

C. No, because it isn't human.

C. It doesn't grow. No.

C. It has a motor. A motor doesn't live.

C. It is only a mechanical thing. It can't move by itself.

T. Is the sun alive ?

C. Yes, because it stays up in the sky by itself. If it was dead it would fall down.

C. No, because it doesn't grow.

C. Yes, because God made the world and the sun. He made sure the sun wouldn't die and it never will.

C. Yes, you can tell by its shine.

C. No. It is just a ball of fire. Fire isn't alive, so how can the sun be alive ?

C. No. I don't think so because it doesn't need food and it doesn't grow.

C. If you weren't alive you would fall over.

C. If you pinch a live person they say " Ouch ! " because they feel things just like animals.

C. If we are alive we grow and breathe.

T. What about plants ? How do we know that they are alive ?

C. They grow.

C. They have beautiful colours if they are still alive.

C. If you break a plant it will still grow if it is alive. But if you chop off the roots it will die because plants need food to live just like us and they get their food from the ground through their roots.

C. If plants don't have water they die.

C. Trees are hard to pull out of the ground if they are alive because their roots are so strong. Even though a tree doesn't move, it is still alive.

From children's hazy, early notions more precise ideas develop, but for this to happen personal, first-hand experience is desirable. It is important that experience should arise out of day-to-day interests and that activities should not be tightly organized and lead to cut-and-dried dogmatic answers. Firm and final statements on the nature of life have not yet been made by anyone. This is one of the fields in which new knowledge is being acquired continually and new ways of organizing data are being suggested.

Some Aims

To provide a rich store of experience should be the teacher's first aim, and to assist in achieving this aim some suggestions have been put forward in Appendix I, " Collecting and Caring ".

As they work, children should be encouraged to develop their ability to observe, to detect similarities and differences, to find things out by experimentation, and to think further about their activities and bring their ideas under some control through communication and expression in language and art.

In all work with living things, it is useful to keep in mind the general theme of " Interactions and Change ". A third aim of the work on life would be to provide experiences that will emphasize that life is an interactive process, characterized by internal change and response to external events.

Living things are constantly interacting with their surroundings. So, in a fashion, are non-living things, which corrode and weather.

But in the case of animals (including human beings) and plants, the exchange is much more a dynamic process ; living things are not only acted upon by their environment, they also act upon it, building up more complex substances. In the process the living organisms also change, by responding to changes with a variety of behaviours and by growing, developing, and reproducing.

All living organisms require certain things from their environment—a source of energy, in the form of food or light, and a variety of other things, which may vary according to the particular plant or animal and its environment. In most large environments there are many smaller environments in which the conditions are different ; in a hot dry climate there are shaded, cool, and relatively moist spots that are the habitats of some animals and plants ; animals may be active only at certain times of the day when conditions are more suitable for them.

A Warning

Care should be taken to avoid ascribing conscious, human motives to animals and plants. It is quite wrong to say that the hand of the clock moves because it wants to get around to the 12 ; it is equally wrong to say that a slater wants (in a human sense) to get under a rock. It moves as a response to a stimulus, perhaps dryness, and ceases movement when the stimulus is removed.

A similar incorrect statement was found in a nature book : " A cockroach has a thin flat shape so that it can crawl into cracks." It is better to say that because of its shape it can live in such places. Probably, at this stage, it is more important for the teacher to set a good example than to correct every mis-statement of a child.

★ ★ ★

The following activities should be regarded as suggestions only and should not be followed rigidly.

LIVING THINGS TAKING IN MATERIAL FROM THEIR SURROUNDINGS

Animals

The child who first brings his pets along will no doubt tell the class what food should be given, and for some time the food monitors should continue feeding in the orthodox way.

The children should observe closely the way in which the animals eat : Do they hold food in their paws ? Do they sniff it ? Do they gobble it or chew it ? Do they bite it off in big pieces, or nibble it delicately ? Children's reports to the class should answer some of these questions.

Some argument among the children should be initiated as to whether their pets *really* like their food or whether they would prefer jelly and ice-cream. By asking children to consider their own foods and meal-times, and at the same time to consider the feeding habits of their pets, some of the following questions should arise :

Do pets eat all sorts of food ?

What do they like to eat best ?

Do they drink much water ?

Do they have three meals a day, like us ?

How do the babies get their food ?

Some of these questions can be answered by observation, but to obtain answers for others, the children may have to try some experiments. The children should plan their own experiments. The teacher may see many faults in what is suggested, but it is advisable to hold back and let the children experiment for themselves.

It is hoped that this work will lead to some discussion around the following points, although no specific teaching should be attempted :

> All living creatures require nourishment, but not all obtain it from the same foods. Cows can get nourishment from grass (their stomachs contain micro-organisms that convert the cellulose in grass into sugars) ; humans cannot do this. The children will not learn all this, but they may be intrigued to think of what would happen in a world where all living things ate the same food.

The living creature obtains nourishment from the foods available in its environment. The rabbit eats vegetation, which is freely available, but not meat, which it is not equipped to obtain. This idea should be comprehensible to young children, even if their ability to express it is not fully developed.

The young of mammals obtain food in the form of milk from the mother.

Suitable creatures for this work would include snails, worms, lizards, frogs, caterpillars, ants, budgerigars, goldfish, white mice, guinea-pigs, pet rabbits, and pigeons, or any creature that is available.

Eating periods. Many animals, particularly plant-eaters such as sheep or caterpillars, spend much of their time eating. On the other hand, dogs remain healthy on as little as two or three meals a week. Discuss how frequently children should eat.

The diets and eating habits of animals can be compared with those of human beings. This will serve to introduce the idea that people need a varied, balanced diet. On the other hand, some animals such as gum emperor caterpillars and sheep usually confine themselves to one sort of food. Activities children undertake might include—

watching a budgerigar pecking at seeds to discover if a particular type of seed is consumed first ;

placing small quantities of possible foods into a box containing slaters ;

transferring caterpillars from one type of leaf to another ; gum emperor caterpillars should be offered leaves of the pepper corn as well as gum leaves ;

providing worms with a variety of small leaves ; keep the wormery dark and note if the leaves are moved or eaten.

Breathing

Do guinea-pigs, budgerigars, worms, fish, and bean plants breathe ? A question of this sort may arise from observations, and in the case of a number of small animals the answer may be obvious, but the question may still provoke closer observation of the process. With fish or plants the answer may not be so easily decided.

By watching fish in an aquarium, the children may learn something of the fish's breathing mechanism. If the aquarium contains an aerator, they may wonder about the need for this. It is more difficult to find out whether plants need air. In one class the children grew bean plants in jars with closed lids, and compared these with plants grown in pots of soil. But the results of experiments of this type are inconclusive and the question must remain open at this stage.

Other activities that the children could undertake might include a study of human breathing ; noting how long children can refrain from taking a breath ; counting breaths taken in a minute ; and observation of a sheep's lungs.

Animals and Water

Follow-up topics to the ones discussed above might include the following :

The quantity of liquid that children drink in a day ; the measurement of these quantities and comparisons of the capacities of the containers used.

Attempts to ascertain the quantity of liquid in fruits or vegetables, for example, an orange, a potato, a tomato ; the children's methods are likely to be crude, but crushing may prove reasonably satisfactory.

Observation of animals to ascertain if they drink ; caterpillars live quite well without drinking.

Observation of the behaviour of caterpillars or other small forms of life when placed near water, or their preferences for dry leaves or leaves covered with drops of water. These observations are not likely to be conclusive and the children should be encouraged to be cautious in interpreting their findings.

Observation of pets ; many cats drink water only rarely, getting their liquid requirements largely from milk. This might lead to speculation about the habits of wild cats. Children might also note the quantities of water that dogs of different breeds drink on hot days and on cold days.

The amount of liquid taken in by pets could be compared with the amount taken in by boys and girls, as well as by adults.

Plants

It is not very easy to find out what plants take in from their environment. Most plants clearly need water, but not all need soil. Lichens, seaweeds, mosses, and liverworts sometimes grow on rocks, walls, and tree trunks. If plants are grown in both lighted and dark situations the children might come to realize that light is necessary for green plants. (Refer to the case study " The Wheat Farm ". See page 56).

It must be emphasized that work with plants, because of the slowness with which things happen, needs to be something of a side-line—a continuous study to which references will be made at appropriate times. It involves regular chores and a need for monitors, who should be selected from all sections of the class and changed regularly. This tends to maintain interest and surrounds the plant studies with a certain aura of prestige.

In this section, as in all others, constant reference should be made to human beings and their needs and habits in regard to food and feeding.

LIVING THINGS AND CHANGE

Movement

Movement is frequently associated with the search for food, the search for a mate, concealment, or shelter from light or heat, or it may be a withdrawal, a response to touch, as illustrated by the following examples :

> A maggot's or a cockroach's movements are often a response to light.
>
> The movements of a slater are often the result of drying out. The slater has gill-like structures for breathing and needs a fairly moist environment. Guinea-pigs and white mice, when placed in a strange environment, may search for a place in which to conceal themselves and from which they emerge at times.
>
> The movements of human beings are more complex, but elements of the movement behaviour of other animals can be noted.
>
> Movement in plants may be less obvious, but it occurs nevertheless as a response to external stimuli of various kinds or to obtain water or food. In roots, this movement may be regarded as a type of growth.

However, in many cases it may not be possible to identify the stimulus which results in movement, and it is therefore unwise to make categorical statements as to why a particular animal is moving. It is useful to encourage speculation, but often there will be several possible reasons each of which seems equally reasonable in the circumstances.

With young children, studies of movement will almost always be associated with observations of individual animals and plants described in the " Collecting and Caring " section (see page 98). Older children may enjoy making comparisons, talking and writing about the movements of humans and comparing them with caterpillars, worms, fish, and dogs. If many living things are being kept, movement in general could become a very profitable topic for investigation, to which a number of other investigations could be linked. For example, as the finding of food is a major activity of animals, work on movement may lead to work on feeding. If the animals are present, questions such as the following may arise in discussion :

How does a worm find its food ?

Does a caterpillar or a slater move around at random until it finds something to eat ?

Other topics for investigation might include the amount of time various animals spend on eating. This, in turn, may lead to a study of the responses of animals and children to the senses of taste or smell. Can we tell what the food is by tasting it with eyes blindfolded ? Of course this does not exhaust the possibilities, and the direction that children's interests take should largely determine the work done.

Resting

Human beings, like many animals, have a well defined daily cycle ; active in the day and resting at night. Children may become interested in the daily cycles of their pets and also the animals in the classroom, and perhaps through this come to collect more information on their own daily routine. Among the questions which could arise and about which information might be collected are the following :

How many hours' sleep do the children in the class have ?

How many hours do adults or older brothers and sisters sleep ?

What is the daily cycle of people working on night shift (if there are any parents in that category) ?

When does a cat or a dog rest—if at all—and for how long ?

Do caterpillars or slaters move about at night or do they eat as much outside school-hours as during the school day ?

In the above sort of work there are many obvious links with applied number work on time.

Internal Movement

Heart-beat

After feeling the heart-beat of a pet, children may extend their inquiries by—

attempting to feel their own hearts beating,
listening to the heart-beat of a friend,
attempting to feel their pulse-beats,
studying animal hearts supplied by a local butcher,
counting heart-beats for a minute.

Muscles

Children may notice that their pets have muscles, and they may also note that these muscles move under the skin. Comparisons might follow with the movements of their own muscles as they raise and lower their legs and arms.

Growth

Investigations of growth, like almost all work with living things, are likely to arise as part of general life studies and are made more meaningful when comparisons between different plants and animals are made.

Animals

Whenever young animals are available, children should be encouraged to devise ways of measuring changes in weight, height, and length.

Tadpoles, mosquitoes, caterpillars, chickens, white mice, guinea-pigs, and other household pets are all useful subjects for these studies. If they cannot be kept at the school they may be brought to school at regular intervals for a day at a time.

Plants

Activities with plants might include the following :

Measuring the growth of plants such as jonquils or daffodils ; cutting coloured paper strips in lengths to show growth in a week, two weeks, three weeks, and so on, from the time the first shoot appears above the ground.

Counting the leaves on bean plants and other plants at suitable time intervals and expressing the results graphically and in tabular form.

Comparing the root growth of plants at appropriate time intervals. Peas, beans, and wheat would be suitable. The plants may either be dug up, pressed, and displayed, or they may be observed growing against glass in jars. In this case, root growth might be represented by lengths of knitting wool stuck singly or in bunches on display paper.

During all of this work, children should be encouraged to measure lengths, heights, and weights in ways appropriate to their level of development. They may use rulers or perhaps cut lengths of string or wool to the correct lengths, or they may weigh, using infant-room scales and such standard units as they feel are suitable. The children should also be encouraged to tabulate their results using pictures or simple graphs. Older children may be interested in discussing factors that seem to them to be influencing growth, such as food, moisture, light, and temperature.

There is an obvious integration of science and applied mathematics in the above-mentioned activities.

Reproduction

Mammals produce their young alive; chickens hatch from eggs, as do caterpillars, ants, and some young snakes. Some creatures are sexed, either male or female; others are both male and female, and yet require fertilization from another of the same species.

In plants, reproduction may occur by cross-pollination or self-pollination and the production of seeds. Other plants reproduce by spores, while there are others that reproduce themselves from a broken branch or twig or root.

This brief survey by no means exhausts the possibilities, but it suggests that there are many investigations children can make in this area.

Plants

Work with a variety of materials is likely to prove most useful. Pieces of mouldy fruit, vegetables, and bread can provide source material with which to start a mould garden. Children will note that the moulds spread, but that there are no obvious " seeds ". There is no need to go into details about spores at this stage. It will be sufficient if children conclude, after studying other plants, that not all plants make new plants in the same way.

Work with potatoes often proves interesting to children, notwithstanding the fact that the experiment needs to be continued over several months. Plant whole potatoes, sections with eyes, sections without eyes, and potato peelings. In addition to planting these in the school garden other pieces should be planted in glass containers so that any development can be readily observed.

Strawberries, couch grass, gladioli, onions, alyssum (sweet Alice), radishes, nasturtiums, and geraniums are plants that could be grown either in window-boxes or in the garden. The children will note how a strawberry plant sends out runners, and they may compare this process of reproduction with the somewhat similar process by which couch grass spreads.

Comparisons between onions and gladioli will show that the gladiolus corm produces new corms, whereas the onion normally reproduces itself by seeding or by the production of small aerial bulbs.

Both alyssum (sweet Alice) and the nasturtium are easy to grow and produce many seeds, which germinate readily.

The geranium grows from a cutting, and roots can be seen forming if a stem is placed in water.

The plants listed above are by no means the only ones that could be used, and the greater the variety, the greater the interest is likely to be.

Animals

If animals cannot be kept in the classroom for an extended period, it should be possible to provide temporary accommodation for a few days, and in these circumstances some discussion may occur on reproduction and care of the young. In any case, children frequently tell the class when their pets have produced young ones, and this provides a natural opportunity for work in this field.

Smaller creatures such as ants, frogs, lizards, pet birds, spiders, and caterpillars are commonly kept in the school and present many opportunities for investigation. However, work with mammals is likely to prove more exciting for the children.

If the animals are kept for some weeks, the children may be able to observe the reproductive cycle, including the birth of the young. The gestation period for rabbits is about 30 days, for guinea-pigs, 68 days, and for white mice, about 20 days.

Children may note that the babies do not hatch out of eggs (although they commonly say the mother rabbit has "laid" some babies), but that they are born alive. Similarly, they may note that the young are fed milk by the mother. Children may also note the variations in the sizes of litters and the differences between the baby and the adult animal. As a result of their observations they will probably be able to give information on how the babies are cared for, the protective instincts in the mother, and the role of the father.

Teachers may wish to tell the children how the baby grows from a tiny egg in the mother. The role of the father can be explained if necessary by reference to the different anatomical structures children observe, and by saying that the father animal gives the mother a "sperm" or living particle that makes the egg grow. Deciding on how much to tell the children can sometimes be difficult. If questions are asked by one or two children while the rest of the class are busy with something else, the teacher may prefer to direct the explanation at the interested children. Only the circumstances and the feeling for the teaching "moment" can guide the teacher. Most children are satisfied by an explanation of the mother's role. If the father's role is queried, the approach suggested above would appear to be natural and suited to an infant school situation.

Responses—Behaviour

All living things respond to stimuli of various kinds. Human beings and other animals respond to touch, heat, light, sound, and smell. Plant life responds to light, touch, heat, and even to gravitational forces (roots generally grow down and leaf shoots grow up). Both plant and animal life respond to other environmental conditions produced by the availability or the lack of food and water supplies. If children can keep a variety of plants and animals, the differences in responses and behaviour can be more readily observed and appreciated.

Plants

Activities that may be undertaken include the noting of changes that occur when plants such as cactus, nasturtium, hydrangea, and various indoor plants are placed on a window-ledge in hot sunlight. The leaves of some plants wilt more readily than others. If whole plants are not available, parts such as leaves or flowers may be compared when placed in hot situations. For example, gazania flowers could be compared with eucalypt blossom. Germinating seeds grown against glass may show differences if the water supply is limited and provided in one place only—near the seed.

Animals, Including Human Beings

Work undertaken as part of general discrimination and classification activities may serve as a useful introduction to broader studies. Work may begin with children studying their own responses and, later, the responses of their classroom pets, or it may go the other way. On the other hand, it is quite likely that the topic may not emerge as a separate interest at all, but will be part of general studies of particular animals.

The following activities may be among those undertaken by the children :

> Discriminating between similar colours ; recognizing shapes, letters, or words at various distances.
>
> Discriminating between sounds ; recognizing words or sentences over various distances and sound levels. A tape recorder would be a useful aid in this exercise.
>
> Activities similar to the ones noted above are possible with the sense of smell. Obtain some closed jars of liquids and solids—water, vinegar, camphor, coffee beans and ground coffee, naphthalene, soaps, perfumes, and herbs. These can be opened daily and, if necessary, the contents placed on cotton-wool. The children could be asked to raise their hands when they become aware of the smell of the substance. If a number of substances are tested, one after another, the children's sense of smell is likely to become confused. This in itself can be an interesting discovery, but testing over a period of time is also desirable.
>
> Keeping warm. Some animals, including many insects, are inactive in the cold months. Birds and mammals have coverings that enable them to keep warm. Only man provides himself with a variety of coverings to adjust his temperature, and has methods of altering the temperature of his surroundings.
>
> Touch. If children explore the surface of their hands they will note that some areas are more sensitive than others. There are quite noticeable differences between the nail, the back of the hand, the palm, and the skin between the fingers.
>
> Children may also undertake simple experiments to determine the reaction of the classroom pets to colours or lights, noises, a variety of smells, and touch (for example, the reaction of a white mouse when its vibrissae or whiskers are touched, or the reactions of a snail when various parts are touched).

If small mammals are being kept, the following questions might arise in discussion :

> Do they talk to one another ? If they don't actually talk, do you think they tell each other things in another way ?
>
> Are they brave ? What would the white mouse do if we banged a drum near him ?

Do they prefer the light or the dark ? Do the animals prefer to hide away in their nests or stay in their exercise area ?

When do they sleep ? Most of the time ? In the day time ?

Are they more lively when they are hungry or when they have eaten ?

Do you think they would like to have an old hot water bottle or a glass bottle of warm water in their house on a cold morning ? How could we tell if they like it ?

Children may argue whether or not these animals do communicate, but it is hoped that their arguments may lead them to consider communication among animals—bird calls, the barking of dogs, the clucking of hens, the first sounds their baby brothers and sisters made, and even what goes on when two ants meet and their antennae touch.

Other Forms of Behaviour

As children care for and observe their pets, they will note a number of differences in general behaviour—that is, different responses to the environment—and they may wish to discuss these responses. Examples include :

The characteristics of animals that help them in various ways ;

the way a cat stalks a bird ;

the way a cat can sheathe its claws ;

the constant nose-wiggling action of a rabbit ;

grooming practices ;

the movements of antennae ;

ear movements ;

the ways in which different animals eat.

Additional Activities

A number of opportunities are likely to arise for treatment of topics closely associated with human health and behaviour. An example of this would be the observation of grooming practices, which could lead naturally to work on human hygiene.

Discussion may develop naturally from observations of the need for cleanliness in caring for pets. Even plants have difficulty in surviving if their surfaces are coated with dirt. Simple experiments and observations of plants in the classroom can confirm this. Take two similar plants and allow the leaves of one to become coated with dust. Sponge the leaves of the other regularly and compare the plants over a number of weeks. An activity such as this does not provide a direct analogy with humans, but it can create an interest from which other things may follow.

When animals are kept in the classroom, the cages must be cleaned out regularly. This could lead children to consider how animals look after themselves under natural conditions. A wide range of animals such as caterpillars, spiders, guinea-pigs, and cats could be studied.

Discuss how humans clean out their houses and what they do about sewage ; also discuss the differences between man and animals in cleanliness, and refer to the way humans clean their teeth and wash their hands.

Parental Care. Children could investigate how cats or other pets feed and care for their young. Other animals studied might include—

hen and chickens,

cow and calf,

ants and their eggs and larvae.

Hospital Play. Infant school children enjoy miming and dramatic activities developing from discussions about doctors and hospitals. A hospital corner, where " nurses ", " doctors ", and " patients " can play would be a desirable feature of any infant room.

Interactions between Animals. Examples of these that children may observe or discuss might include fights, bristling, growling, and baring of teeth. Examples of co-operative behaviour might be noted in the class and on the farm, among nesting birds, or in a hive of bees. Other interactions may be noted among people. For example :

What would it be like if everyone talked and no one listened ?

Why do children take turns at the school-ground climbing equipment. or at skipping ?

Environmental Dangers ; Health and Safety Awareness

A number of topics already mentioned are related to " Safety First ", but there are other topics that are closely linked to the external environment which can be investigated. This may involve listing possible sources of danger, such as busy streets, cars, bicycles, running around corners in the school-ground, playground equipment, slamming doors, electrical equipment, various dangers in the kitchen, poisonous liquids, dangerous tools and garden implements, and many others.

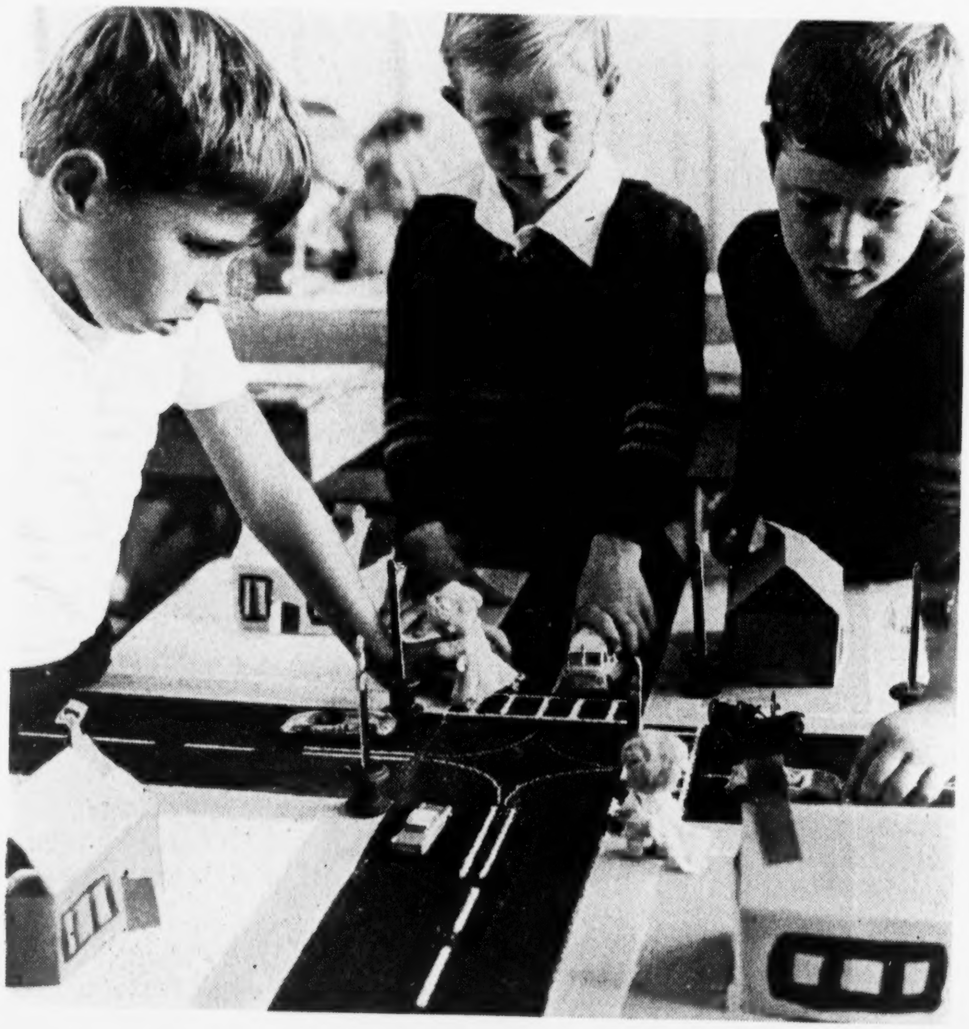
Cuts, Sores, and Abrasions. It is easy for the children's interest in these to get out of hand, but nevertheless at times the methods of treatment should be a topic of investigation for the whole class, so that all children note the need for cleansing the wound, the use of an antiseptic, and the application of a bandage to prevent the entry of dirt. The rate of healing of wounds may also be compared.

Blood, Skin, and the Healing of Wounds. Observations of these follow naturally from the previous activities, and they should lead children to note the skin's capacity for regrowth and the way blood will clot and thus promote healing.

Common Ailments—Preventing the Spread of Disease. The collection of information about these may be encouraged.

Accidents and Simple Graphs. Column graphs could be made to summarize data about the types of accidents children have had or have narrowly avoided during a week or some other period.

Other graphs could be made to show other information relating to safety. These might include graphs of the numbers of children who cross various busy streets on the way to school ; children who use particular safety crossings ; the types of poisonous liquids found in the laundry or the bathroom ; or the numbers of children who have had various infectious diseases.



A traffic table set up in a corner of the room could provide opportunities for developing traffic awareness. Streets, the school, shops, and crossings could be marked on a table-top and the buildings made with construction blocks which children bring from home or which may be available at the school. Small groups of children can play at the table with toy cars and pedestrians, practising sensible road behaviour, and simulating real traffic situations. *Knowledge gained can be extended in the school-ground and applied during excursions and journeys to and from school.*

VARIETY OF STRUCTURES

Children should become aware of the great variety of structures of living things. Many of these structures are the result of evolutionary adaptation that has occurred as a response to the environment, resulting in certain features of plants and animals which increase their chances of survival.

Animals

Finding answers to the questions raised in a study of the structure of animals involves close observation. A start may be made by raising the general problem : " What can we find out about the bodies of animals ? " This can be broken down into sub-problems, which children should be encouraged to suggest and investigate. For example :

> What can we find out about animal heads ?
> Are all animal paws like the paws of a dog or a cat ?
> What can you find out about the ears of animals ? Are they the same as our ears, or a dog's ears ? Can they be turned ?
> Why is it useful for some animals to be able to turn their ears ?
> Do all animals have whiskers ? If so, why ? What do animals do with their whiskers ?
> Are animals' teeth like ours ?
> Why do some animals have fur ? (There is a possible lead-in here to talks about the most suitable clothes for boys and girls.)
> Have you ever seen a green guinea-pig, a pink rabbit, or a white mouse ?
> What are the common colours for these animals ?
> Are animals' eyes the same as ours ? Our eyes are at the front of of our head.
> Why do animals' eyes tend to be otherwise ? (This gives them a wider arc of vision.)
> Do animals have hearts ?

Some of these questions may be suggested by the children. Others may have to be suggested by the teacher. Few children are likely to raise the problem of why there are no green guinea-pigs, but the question may encourage them to find out what they can about the colours of guinea-pigs.

Body structure is related to environment, that is, to the habits of the animal, its way of life, and its surroundings. As children progress through the school, they may investigate this in more detail and compare body structure systematically, noting adaptation to environment.

The study of many living creatures, involving the structure and function of their body parts, provides a background of experience and information for better understanding when studies of humans are undertaken.

Studies of worms, slugs and snails, slaters, millipedes, spiders, ants, butterflies and moths, fish, frogs, lizards, tortoises, birds, white mice, guinea-pigs, and rabbits offer opportunities for comparisons with human beings.

This approach through other living things is recommended because it allows children to make close personal observation and entails an active investigation of the problems associated with human health, rather than a passive acceptance of health rules.

Some Sample Comparisons

Some of the things that children can study and make comparisons of include the following :

Antennae of a butterfly or moth, the eyes and eye stalks of a snail, human eyes.

The paws of a cat, a dog, a human foot.

The body covering of a crab, a fish, a rabbit, and a human.

Counting the limbs (" arms " and " legs ") of various creatures. Do dogs have " heels " and " knees " ?

Heads and jaws of various creatures including the praying mantis and the caterpillar, as well as human beings.

The foot structure of a perching bird (a budgerigar or a hen) as compared with the foot structure of a duck.

Examination of X-ray Photographs

If any child should be so unfortunate as to break an arm or a leg, which needs to be X-rayed, or if an older member of the family can get hold of a dental X-ray, these photographs can provide added interest to a simple study of the bones of humans and animals. Children may note the position of bones in their own bodies by feel, and interest in this can add more point to a discussion of the need for care in the school-ground and around the home to avoid breaking bones.

Plants

Wide variety can be observed in the structure of plants. An examination of the plants in the school garden will confirm this. A list of interesting plants is included below. Many of these plants are suitable for growing in school gardens, and most are available from the Victorian State Schools' Horticultural Society :

Ampelopsis, clematis, pelargonium, crataegus (hawthorn), berberis, prostanthera, spiraea gracilis (English may), hakea laurina (Australian pincushion), agonis, dodonaea, callistemon, stachys (lamb's ear), lasiandra, ilex (holly), cacti, sanserveira (snake plant), mesembryanthemum (pig face), beloperone (shrimp plant), garrya, acer negundo, lavender, ceanothus, globe amaranth, gaillardia, leonotis leonurus (lion's ear), kochia, verbena, cercis siliquastrum (Judas tree), melaleuca incana.

APPENDICES

APPENDIX I

COLLECTING AND CARING

A "LIFE" UNIT FOR ALL LEVELS

Objectives

To suggest ways of ensuring the availability of a variety of forms of life for children to study. Without the presence of living things it is impossible for children to undertake any serious, scientific study of life.

At the conclusion of their activities children should be able to describe some of the factors that must be taken into account in caring for the living material they have collected.

Children should become aware of the dependency of living material on the environment that maintains it, and be able to express this awareness in a manner suited to their level of development.

During this work children should also become aware of the fact that this relationship with the environment is shared by all living material, which allows a number of valuable comparisons between plants, animals, and humans to be made.

The suggestions given here cover, it is hoped, most of the main orders of living things. This has not been done to facilitate teaching of strict classification systems, but simply to assist in the carrying out of a wide range of discrimination and grouping activities that are basic to scientific study, and to thinking generally. Classifications may be attempted, but they will be the products of the children's own observations and discussions and, as such, they may show considerable variations from accepted adult systems.

This section should be read in conjunction with material on "Discrimination and Classification" found elsewhere in this Guide.

ANIMALS

Under this broad heading we shall include worms, shell-fish, slugs, snails, slaters, spiders, ants, mosquitoes, caterpillars, butterflies, moths, fish, frogs, lizards, tortoises, birds, white mice, guinea-pigs and rabbits.

In country areas the creatures collected may vary, depending on the locality and the availability of native species. The list given above is simply meant to be representative, not exclusive.

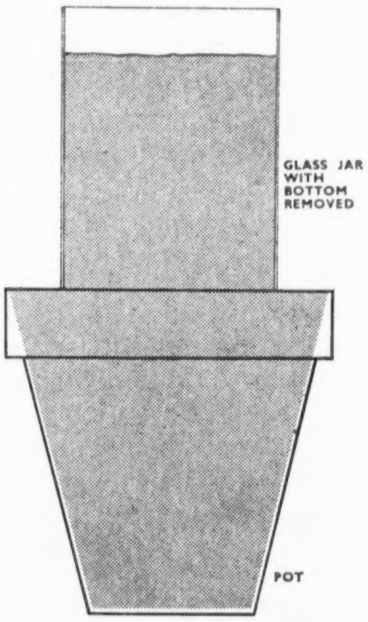
Worms

> As I was led to keep in my study during many months worms in pots filled with earth, I became interested in them, and wished to learn how far they acted consciously, and how much mental power they displayed. I was the more desirous to learn something on this head, as few observations of this kind have been made, as far as I know, on animals so low in the scale of organization and so poorly provided with sense organs, as are earthworms.
>
> In the year 1837, a short paper was read by me before the Geological Society of London, "On the Formation of Mould", in which it was shown that small fragments of burnt marl, cinders, etc., which had been thickly strewed over the surface

> of several meadows, were found after a few years lying at the depth of some inches below the turf, but still forming a layer. This apparent sinking of superficial bodies is due, as was first suggested to me by Mr. Wedgwood of Maer Hall in Staffordshire, to the large quantity of fine earth continually brought up to the surface by worms in the form of castings. These castings are sooner or later spread out and cover up any object left on the surface. I was thus led to conclude that all the vegetable mould over the whole country has passed many times through, and will again pass many times through, the intestinal canals of worms.—Charles Darwin, *The Formation of Vegetable Mould through the Action of Worms with Observations of Their Habits*, John Murray, London, 1904.

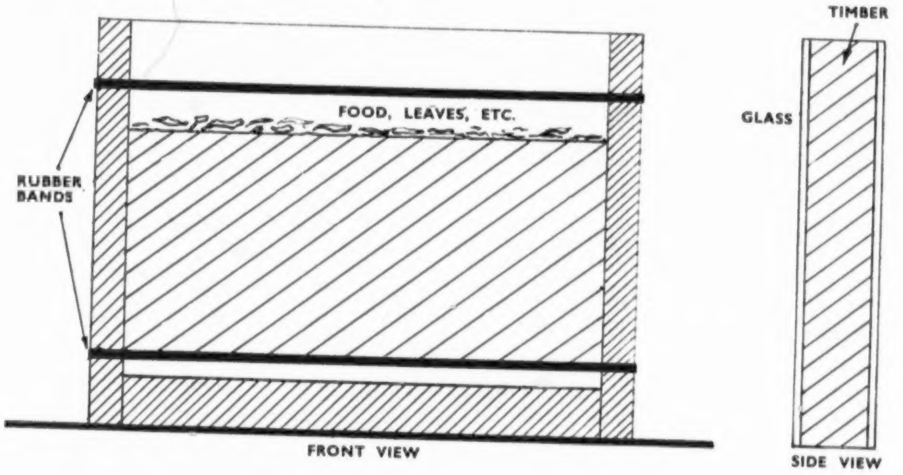
If Darwin found enlightenment through keeping worms in his study, it is likely that children may do likewise by keeping them in the classroom. Darwin's work on the subject is a classic which in many ways provides a model for children to emulate, showing how much there is to be discovered from the close observation of simple things, when the observations are backed by the working of a keen, inquiring mind. Darwin's work has been mentioned here to emphasize that worms are well worth keeping, provided that purposeful observations are undertaken.

Worms can be kept in pots or glass jars filled with different mixtures of earth, leaf-mould, pieces of stone, gravel, and food-stuffs. The containers should be kept moist and covered to exclude light. However, the following set-up is preferable :



A snug-fitting cylinder of black paper or card to slide over the glass jar should be used to exclude light and to encourage burrowing close to the glass. The bottom of the jar may be removed by placing the jar in half an inch of cold water and carefully pouring very hot water into the jar. The bottom should split off, but several jars should be on hand in case the first attempt is unsatisfactory. Warn children about the sharp edge of the glass. A cylinder may also be made from a rolled sheet of thin plastic, if this is available, or an old lamp-chimney could be used.

Another satisfactory wormery may be made from two sheets of glass and a length of 1″ by 1″ timber.



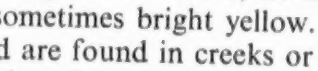
It is rarely satisfactory to have only one container of worms, as this does not allow the children to make comparisons and determine the effects of certain environments on the worms. These questions will be considered in a subsequent unit. They are mentioned here to stress the fact that collecting worms or making a classroom zoo is not enough and must always be associated with activities aimed at gaining information about environment and behaviour and maintaining life successfully. More valuable comparisons with other forms of life can then be made.

Other Worms

These include land and water planarians and leeches. Land planarians are often found in damp places in the bush, particularly on the undersides of fallen logs or branches, or around the garden under flat timber. They are sometimes bright yellow. Water planarians tend to be reddish-brown and are found in creeks or ponds, sometimes under stones or debris in sheltered positions. They may also be obtained by sinking a jar containing a few pieces of chopped liver in the water.

The planarians can be kept in a fish-tank or a plastic container of pond water. No great depth of water is needed, but attempts should be made to replicate the environment in which the planarians were found. The children should realize that it is important to replicate the natural environment not only in this experiment but also with any other experiment that is carried out in the classroom.

Planarians change their shape, but their general appearance is depicted below :



(LENGTH APPROX. ¼″)

A number of interesting activities can be undertaken with planarians, which because of their insignificance and retiring behaviour are often overlooked as subjects for investigation in the primary school.

Little needs to be said about leeches, but if available they also are worth collecting so that comparisons with other worms can be made.

Ants

Commercially made ant " nests " are available and are suitable for short-term observation work with small ants. However, some children may be interested in studying larger ants or noting what happens when several varieties are placed in the same container. In this case the following suggestions may be useful.

(*a*) *Horizontal Ant Homes*

Material : 2 sheets of window glass of a suitable size ;
modelling clay ;
a shallow tin or plastic dish, plastic sponge.

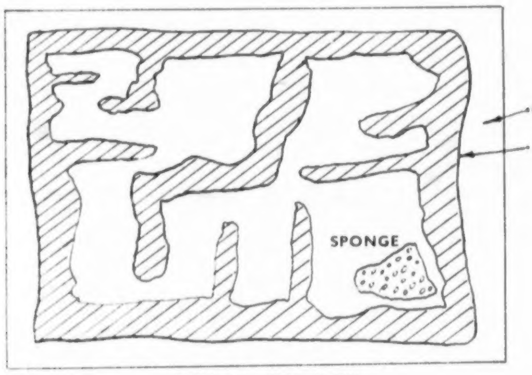


FIGURE 1 : TOP VIEW

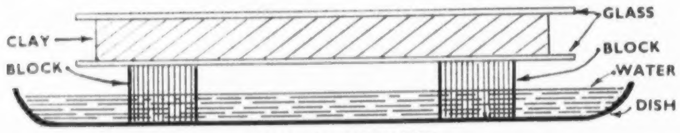
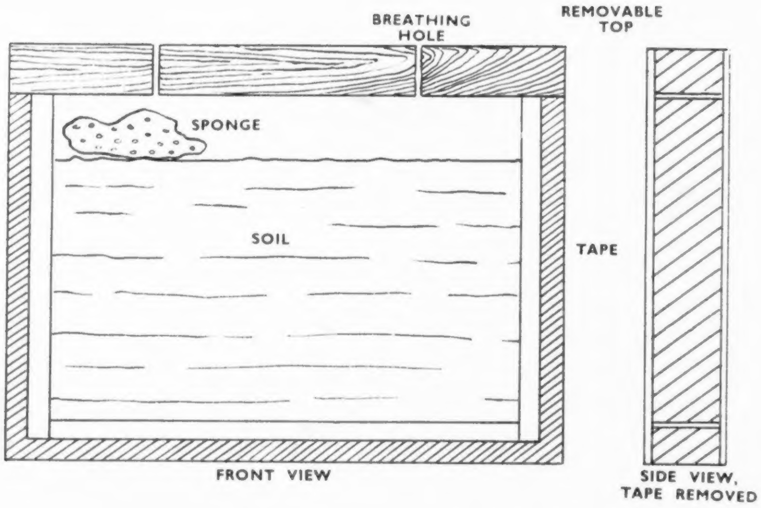


FIGURE 2 : SIDE VIEW.

Clay should be pressed onto one sheet of glass as shown in Figure 1. The other piece of glass can then be pressed firmly on to the clay. If the sheets of glass are placed on blocks in a dish of water, the ants cannot escape. When the ants have been gathered they can be supplied with soil, food, and water (in a damp sponge) by lifting the upper sheet of glass. Keep the interior dark by covering the glass with a sheet of cardboard when the ants are not being studied.

(*b*) *Vertical Ant Homes*

Material : 2 sheets of window glass of a suitable size ;
lengths of timber 1″ by ¾″, or similar ;
adhesive tape 1½″ to 2″ wide (if available).



An envelope of dark, thick paper should be made to cover the apparatus when the ants are not being studied.

(*c*) *Obtaining the Ants*

This is not always easy and, if necessary, older children may be needed to help with the collection. Care must be taken not to injure the ants during their transfer to their new home. Once a nest has been located, ants (including, if possible, a queen), eggs, and some soil may be collected with a spoon, which should be tapped smartly to remove the ants at the appropriate moment.

Care

The ants should not be overfed ; food material that is likely to go mouldy should be avoided ; water should not be excessive ; and the container should not be moved unnecessarily. At the outset, the ant home should be covered for several days to encourage the ants to dig and to adjust to their new environment. The ants should be kept in subdued light conditions.

Slaters (Wood-lice)

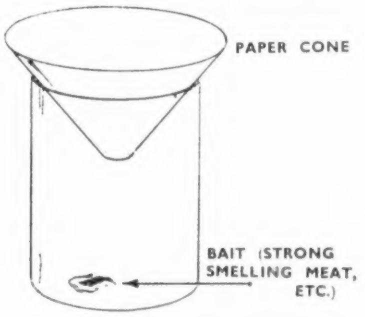
Children should have no difficulty in finding slaters, which abound in sheltered spots under rocks, low plant-cover, and rotting wood and leaves. However, when brought into the classroom, they will soon die unless a moist environment is provided. Slaters are crustaceans, but unlike many crustaceans they have forsaken the water, requiring only moist air in their breathing.

A fish-tank, even if it is no longer completely watertight, or a large plastic dish can be used to make a home for the slaters, where they may be kept indefinitely and bred. Once again, making the proper environment is a creative task for children, and this provides opportunities for the children to develop their imaginative and artistic skills. They should use plant cover, flat stones, leaves, and humus or peat. Moisture can be supplied with a fly-spray pump filled with water and used regularly.

Spiders and Insects

A fish-tank or dish with a glass cover may be used as a cage for a spider. A smaller box should be placed inside as a shelter. Catching live bait presents problems, but flies may be caught by covering them slowly with a jar.

This problem can be overcome if spiders are studied in conjunction with flies. A suitable fly-trap is shown below :



Mosquitoes are easier to collect in the larval stage and they also are worth studying.

Earwigs, cockroaches, and silver-fish are regarded with considerable disfavour by adults, but this prejudice is not always shared by children and these animals may be studied by them with profit, provided adequate precautions are taken. Fish-tanks or dishes should be used as containers in which suitable environments can be created, so that behaviour of insects can be studied and compared with the behaviour of other creatures (slaters, for example). A variety of foods should be offered, although for many insects powdered dog-biscuit will provide a satisfactory diet.

Yabbies, Mussels, Water Snails, and Fish

Yabbies, mussels, water snails, and fish have been treated together, because they require the use of a pond or a fish-tank. In any classroom, fish-tanks may be seen, but a fish-pond in the school garden is less common. This is a pity, because a large pond provides an opportunity to create an environment in which a large number of living things can be kept under more natural conditions. In one recently built suburban school, while the garden was being laid out, it was decided to include a fish-pond, and this led to an enterprise in which many of the children participated with enthusiasm. At first, the building of a pond was considered, but the Mothers' Club donated money for a large preformed concrete tank costing about fifteen dollars. When it finally arrived the children gathered round, watching with great interest as it was lowered to the ground.

The first inhabitant of the pond, a yabbie, arrived the next day and was soon swimming about, watched by a large audience, but within a few days it was dead. It was agreed that the freshness of the concrete was probably to blame and the pond was filled and emptied a number of times before re-stocking commenced. A siphon was used to empty the tank, and this led to work with water and plastic tubing in a number of classrooms.

The next inhabitants were some gold-fish which were soon joined by several Murray crayfish obtained by one of the teachers, a fishing enthusiast, from an old Murray "whaler". The children, most of whom had never seen such fearsome creatures, watched with awe and remarked on the obvious power of the nippers. The fishing enthusiast returned from another week-end trip with some carp from an irrigation channel, and the pond became the main focus of interest in the school-ground. The pond had been strategically sited near the main gate and it was now under constant observation from a steady stream of children both before and after school as well as during recess.

However, the pond looked rather bare, standing on bare earth, which by now had been trodden hard by the children. It was therefore decided to build a rock garden around the pond and each grade was invited to work on the project. Bigger children moved rocks and earth, while the infants placed suitable plants, shells, and even gem stones in the crevices. Other rocks were placed in the pond to provide shelter. Water plants were also brought along, including some water-lilies.

By this time the children exhibited great pride in their pond, and took a delight in showing it to visitors. More gold-fish arrived, several tortoises, a frog, and even a lizard that swam rapidly across the pond and disappeared among the rocks on the far side. During the next few days it was noticed that some of the inhabitants of the pond had disappeared, and the children speculated darkly as to their fate and the likely culprits.

It is worth noting that in a number of classes a good deal of written work was produced on the pond and its inhabitants, and thus it served a double purpose, in science and in English.

Indoor Fish-tanks

In many schools the activity described above would not be possible and indoor fish-tanks are the only alternative. These tanks are often used with a filter and an aerator. However, if a filter is used, it is difficult to keep smaller forms of life such as water-beetles and daphnia which tend to get caught in the filter and die. As these small creatures are well worth keeping, it may be preferable to do without the filter and aerator and keep fewer fish along with more smaller pond-dwellers. However this is a matter for personal choice.

Pond-life and small river fish, yabbies, and so on may die if transferred into pure tap water. Any tank water should be allowed to stand for several days before fish are added, and if pond-life is used a quantity of pond water should be added to the fresh water. Many small forms of life can be found in the mud at the bottom of a pond.

Daphnia and other small forms of life, and the larger "toe-biter" and water-tiger, abound during the early spring in water-filled depressions in paddocks as well as in the shallow ponds that dry up in summer and that should be explored by children in country or outer surburban schools. Children in more built-up areas may find many other forms of life in the ponds in municipal parks or botanical gardens. Tanks need to have an abundance of shelter for these creatures and should therefore be well planted with water plants.

If a fish-tank is not available, a large jar is quite useful for holding forms of pond-life and, in fact, can be a most beautiful and fascinating focus of interest in any classroom where space is a problem.

In some circumstances it is possible to set up an aquarium for tropical fish. In one school it was decided to place the tank on a long table in a corridor which was a thoroughfare for children from a number of classes. By a happy chance the stocking of the tank was done by an interested shopkeeper, who made sure that one of the fish was a female guppy, heavy with young. Not long after the tank had been set up the young fish began to emerge—just before nine o'clock one morning. The word spread, and children from all grades gathered to watch the process.

For weeks afterwards children were to be found congregated around the tank at odd moments during the day. The table on which it stood became a resting place for the objects of interest found by the children. An insect cage was set up beside the tank, and the fact that the table was a centre of interest for all classes tended to break down the barriers to interclass communication. Children in Grade VI were to be found in the infant rooms telling of their discoveries and, on occasions, the younger children repaid these visits. After some time, another female guppy produced young fish, and interest was kept at a high level.

Salt-water Tanks

Excursions to beaches and rocky tidal pools are to be encouraged, but care must be taken, especially in bayside areas, not to denude the pools of life. This may happen if a large number of schools are in the habit of visiting a particular spot and take living specimens back to school with them. Any specimens taken should be returned to the sea the same day. Rocks that are overturned should be replaced as they were. However, it is sometimes possible to set up a salt-water tank to observe marine life. Two tanks are needed and a constant flow of water from one to the other must be maintained with a pump of the type used to work the aerator and filter of a fresh-water tank. Take great care not to overcrowd the inhabitants of the tank. Top up the water with ice-blocks when necessary.

This is not an activity that every teacher would care to undertake, but it might be worth while for the interested teacher who wishes to build the major part of the year's work with living things around the aquarium.

Tortoises, Frogs, Axolotls

Some small fresh-water tortoises that may be kept in a fish-tank are available ; similarly, frogs may be kept if suitable platforms can be placed above the water in the tank and a glass sheet or wire-netting cover is available.

The axolotl which is sometimes available is an intriguing creature and arouses tremendous interest among children. This reptile breathes through feathery gills around the head, and it may remain motionless in the tank for hours at a time. If a tiny piece of chopped meat is lowered into the tank, the axolotl is aroused to fearsome activity and gulps the food ferociously. Small water creatures are stalked and suffer an equally savage fate.

In some ways the axolotl may be said to exist almost permanently in an intermediate " tadpole " stage, but it can be made to change into an adult air-breathing form that uses its lungs for breathing. Place the axolotl in a shallow tank and gradually reduce the water over a period of several weeks, but keep the environment very moist by spraying the interior of the tank with water at frequent intervals.

Fish-tanks that develop a slight leak should not be discarded but should be used as vivariums for keeping frogs, land tortoises, and lizards. A plastic dish surrounded with soil can be used to provide water. Small plants and rocks will provide cover and an appropriate environment. Meal worms, small earthworms, and flies are a suitable diet. The appetites of these creatures are not large and they may be kept and observed for some weeks without feeding. If feeding is not attempted the creatures should be released when activities with them have been completed.

Slugs and Snails

The keeping of slugs and snails presents no real difficulties. They may be kept in a tank or a large jar containing grass, soil, rocks, and food materials. To prevent slugs and snails covering the glass walls with slime and escaping, try smearing vaseline around the glass an inch or two above the grass. Spray the interior of the tank with water when necessary. A fly-spray pump is useful for this job.

Caterpillars, Butterflies, and Moths

Children experience little difficulty in collecting caterpillars, butterflies, and moths although it is unfortunate that the night-flying varieties are not sought more often, since most moths are nocturnal. A collection made on a summer evening will probably result in a surprising variety of moths and insects that can be brought to school for closer study. Jars, insect cages, and covered tanks can be used to accommodate the collections.

Caterpillars are commonly kept, but efforts should be made to obtain a variety of types, so that comparisons can be made.

Birds

The close study of birds presents many problems since their proper place is in the open where their freedom is unbounded. Many teachers regard the caging of birds as distasteful, and yet the practice is wide-spread. Children often keep birds at home, but the teacher may have scruples about keeping them at school. This is a question that only the individual teacher can solve, but it is hard to see how any study of living things can ignore birds, and birds cannot be studied at a distance.

In one school the problem was tackled in the following manner. The school was situated in a working-class neighbourhood and many of the fathers and children were bird fanciers. Some kept budgerigars and other small birds which they bred for pleasure. Others, including a number of Europeans, kept pigeons, sometimes as a dietary supplement. The teacher, who taught a class of Grade III children, had misgivings about caging birds, but he decided that in this environment his misgivings could be stifled, at least temporarily. One child brought a large wooden cage to school, and the father of another child donated a pair of budgerigars. The children loved the birds. They fed them, talked to them, watched their movements, and wrote stories—some imaginative, others strictly factual and " scientific "—about the birds.

An interest in other birds was aroused. One boy had an older brother who bred pigeons, and these were studied and later released to show their homing ability. A hen was brought to school on another occasion, and later, a duck. The children studied these in the playground, searching for the best words to describe the birds' structure and behaviour. They were surprised to find that the birds had ears. They watched them eat and walk. They spread the birds' wings and were impressed with the size of these. Later, they returned to the classrooms and wrote. Once again factual and imaginative work was produced according to individual choice.

Later the hen budgerigar produced eggs, but unfortunately these did not hatch. However, the owner of a small poultry farm near the school allowed the children to visit his farm. The incubator was seen in operation and a chicken emerged from an egg while the children watched. Interest in birds was still high when the holidays intervened. There were many more local birds (mostly sparrows and mynahs) that could not be studied because of the shortage of time, and the activity had to be terminated, regretfully.

This study suggests one solution only to the problem of keeping birds, but there are others. In one grimy inner-suburban school where a few dispirited sparrows used to crouch on a window-ledge, the children brought some boards and fixed them outside the window to make a feeding and observation platform. In a number of schools overseas, the problem of keeping birds and other animals has been solved by erecting small wire enclosures in the school-ground where the children keep pigeons, guinea-pigs, and other pets that can be brought into the classroom when needed. An animal enclosure in the school-ground would create a centre of interest on which many activities could be based.

Small Mammals

Included among small mammals that could be satisfactorily studied at school would be children's pets such as dogs, cats, rabbits, guinea-pigs, and white mice, and in country areas calves and lambs might also be studied. Some of these animals could not be kept at school for longer than a day, but this is not a disadvantage where a sudden growth of interest occurs and the children set about making comparisons, such as happens on " pet day ". Nevertheless, this is not a substitute for study over a longer period, and for this work the most suitable animals are rabbits, guinea-pigs, and white mice, or possibly white rats. Whichever animal is chosen, care should be taken to provide suitable living conditions. Wooden cages are not very satisfactory since they are difficult to clean, especially if the base is also wooden. If no other cage is available, the base should at least be covered with adhesive plastic shelf lining.

To prevent the cages from smelling, the base should be covered with peat, sawdust, and shavings, or the cat " litter " sold in pet shops. The cage should be cleaned daily. Failure to attend to these basic points will lead to failure in a wider sense. Small animals kept in unsavoury, noxious conditions are unlikely to provide good learning material. If white mice are kept, a cage with a fixed nesting box is not suitable, since the mice tend to retire to the box and are rarely seen ; a small nesting box with a loose top is better, since the box can be removed when desired.

Few difficulties are likely to be met in feeding. A variety of foods in small jars should be provided, the daily quantity being reduced until almost all of the food supplied is eaten each day. In this way an adequate ration can be determined and feeding experiments undertaken.

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This section of the Guide has merely indicated some of the animals and small forms of life that can be kept. The point that must be emphasized is that it is necessary to maintain variety so that useful comparisons can be made. Animal care presents few problems if the work is properly organized. The actual work should be done by the children, not by the teacher. This is not to save the teacher from extra work, but to provide the children with opportunities to undertake useful work, to develop responsibility, and to engage in co-operative activities with other children.

PLANTS

Once again, the aim should be to provide a rich experience. This means that children should work with a wide variety of plants so that useful comparisons can be made. A highly developed ability to observe is of little practical use if the materials observed are limited both in number and in variety of types. Variety not only makes more observations possible, it also makes them meaningful. For example, it may be of some value to plant some wheat seeds on moist cotton-wool, and then to watch them germinate. It is an activity many teachers grow tired of seeing, but it is something that young children find very interesting, at least for the first few times. However, it is of limited value if this is the only seed being germinated or if other types of seeds are germinated at a later date. Far more value is derived if a wide variety of seeds are germinated together so that differences in habit and rate of growth can be compared.

Consider some of the observations that could be made :—

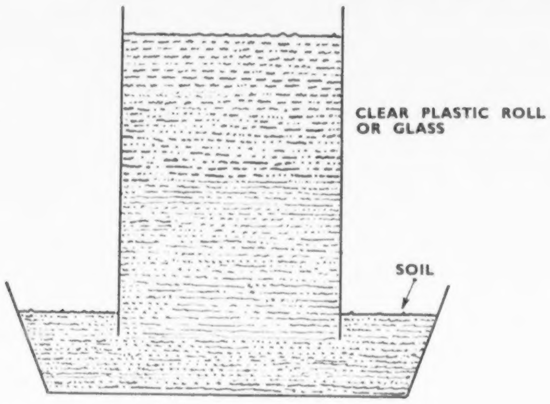
1. The appearance of the seeds.
2. The size of the seeds. This is not a simple matter calling for the use of words such as " tiny " or " big ". What children should be interested in is *how* tiny or *how* big. Some seeds, for example, mustard seeds, are so small that they are difficult to measure with a ruler. Even if the seeds could be measured it would not tell us much. A far more interesting comparison between small seeds and large seeds can be made by finding out how many of them are contained in, say, a level tea-spoon or coffee-spoon. Alternatively, the number of seeds needed to balance the weight of a known object might be compared if a sensitive balance can be constructed. (The milk straw—paper cake-cup balance described in the " Matter " unit, " Comparisons of Liquids ", in Part C, *Branching Out*, would be useful for work of this nature.)
3. The rate of growth of the parts of the germinating plant. Once again measurements need to be quantitative, and if a variety of seeds are being studied this can be a demanding task. But the measurements themselves are of little value. They represent " raw data " which must be organized, and there is no " best way " of doing this. In fact, the best way involves many ways—tables, pie graphs, histograms, line graphs, and variations of these that individual children make for themselves.

It is unnecessary to go on, since the purpose of this section is to suggest some suitable plants. Activities that might be undertaken are suggested in later sections, but the importance of comparisons needs to be clearly understood.

Where To Grow the Plants

The simple answer to this is " wherever possible ". If plants can be grown only in saucers, pots, or jars on window-ledges, this is better than not growing them at all ; but it is not the same as growing them in the garden. It is possible that many city children believe that wheat is a small green plant, and they may wonder how it ever produces more seeds if their only experience of growing it is limited to a saucer in which it germinates on cotton-wool. If space is available, let the children plant seeds of barley, oats, wheat, and rye in a patch of the school garden, during the autumn months. Relatively " large scale " work of this type is usually more successful as a learning experience than the growing of a few seeds in a pot or a window-box, principally because social interaction and physical activity can be raised to a high level. Where a window-box is used, these important factors in learning among young children are often not present. This is not to say that " small scale " work is valueless ; on the contrary, without it careful experimentation would be almost impossible.

When seeds are germinated in jars, against the glass so that the process can be studied, the seeds frequently become covered with mould, due to the fact that the soil or sawdust is poorly drained. Comparisons should be made with seeds planted in well drained situations in pots, in rolls of stiff clean plastic standing in dishes of soil, or in a jar from which the bottom has been removed by standing the jar in an inch of cold water and then pouring very hot water carefully into the jar.



It is essential that a variety of plants should be grown in a variety of growing situations.

Suitable Plants To Grow

Setting out a list of plants according to accepted botanical classification is fraught with dangers. In particular, it might encourage teachers to teach according to the same principles ; this is undesirable at the primary school stage. Children will of course classify, but their classifications will be in accordance with their level of experience and logical development as indicated at the beginning of this section. Therefore, some suitable plants are grouped below in much the same way as they might be suggested in the classroom.

Vegetables : Beans, peas, silverbeet, potato, tomato, radish, onion, mustard, cress, lettuce.

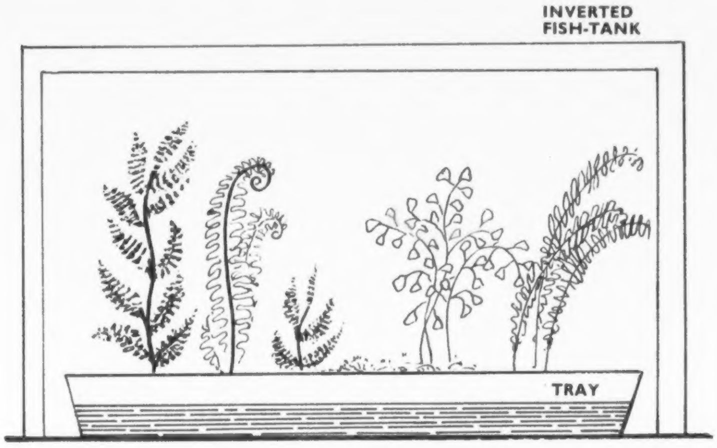
Flowers : Nasturtium, ranunculus, gladiolus, tulip, jonquil, daffodil, dahlia, carnation, geranium, Christmas daisy, coleus, chrysanthemum, fuchsia, verbena.

Trees : Seeds of oak, apple, plum, etc., as well as wattle and eucalypts. Wattle seeds will germinate well if boiling water is poured over the seeds and they are left overnight before planting.

Children will notice that they swell up after this treatment. If " gum nuts " are collected and kept in a paper bag, many small seeds will fall out. A comparison between the " gum-nut " and the fruit of an apple or a peach can be made.

Grasses : Wheat, oats, rye, and barley mentioned earlier are grasses, but there are many others besides the ones obtained from a nurseryman. A walk through a paddock or vacant allotment in late November or early December will enable children to collect many varieties of grasses and weeds, with their seeds. These can be kept and used during the following year. The study of a paddock is referred to in some detail in the " Life " unit, " Groupings and Communities ", in Part C, *Branching Out*. The creeping grasses such as buffalo, couch, and kikuyu can be grown if pieces of the roots are collected and planted. Weed and grass seeds usually germinate well and grow quickly, providing useful material for growth rate comparisons and for discussion on the need for weeding and reasons for success in growing these plants.

Ferns and Mosses : Fish-bone fern and maidenhair, along with whatever moss is available, grow well in a fish-tank used as a vivarium. In one school the following arrangement was seen.

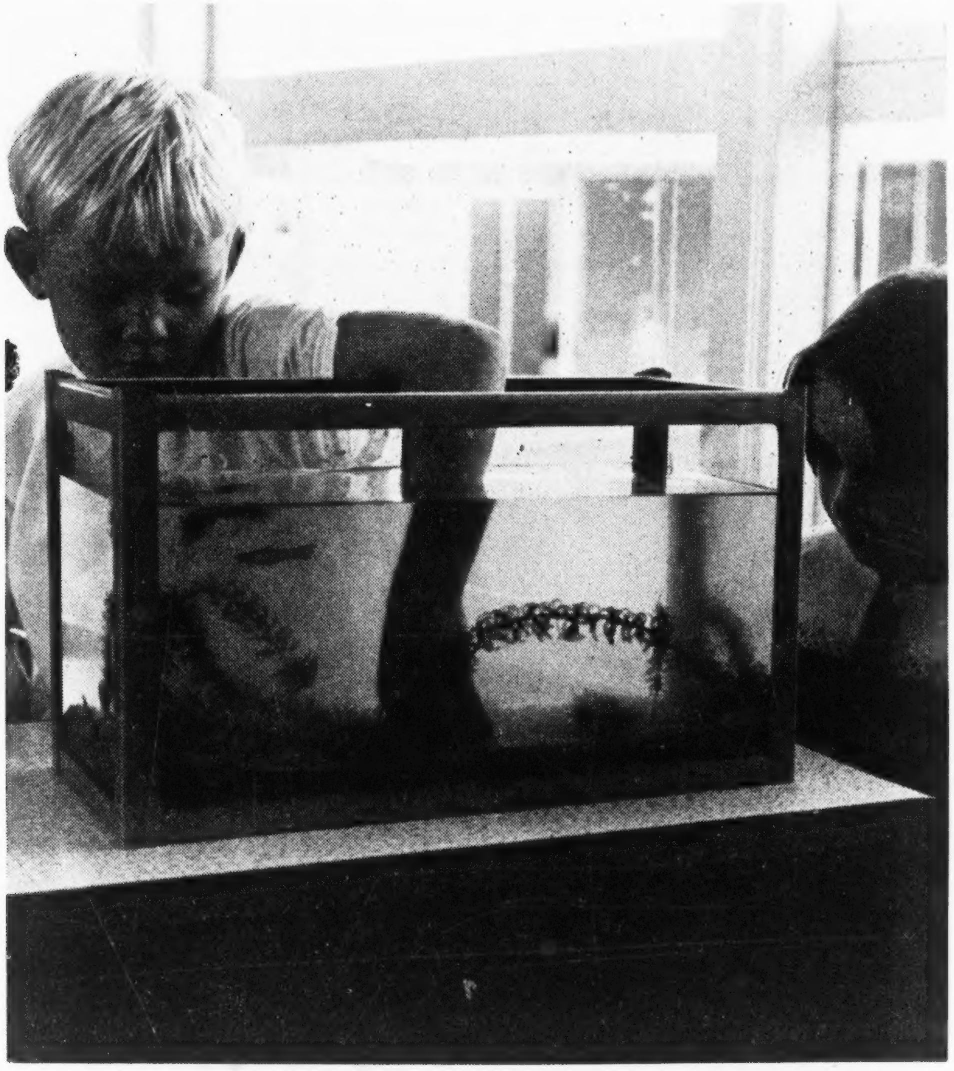


Very little watering was required. Moisture formed on the inside of the tank and the children compared this phenomenon with the fact that moisture formed on the outside of an adjacent tank containing fish.

Fungi and Moulds : The upturned tank and the tray shown above would also provide a suitable environment to keep a piece of rotting log or decaying pieces of timber found in a rubbish heap or in some dark moist corner. In such a situation a number of fungi will keep growing for a time.

There may be some teachers and children who would like to grow mushrooms at school, and this is not a very difficult project if the tasks are farmed out among the group. Information can be obtained from the Department of Agriculture, Melbourne.

Moulds soon grow on bread, pumpkin, and other food materials kept in a plastic lid and covered with an upturned jar. Children enjoy trying to " infect " one material with mould growing on another material. They also like to grow moulds in a variety of environments and to note what happens when the food is placed in lightly covered glass jars, heated in an oven, and then sealed tightly after removal from the oven. Comparisons can then be made with the same foods not given this treatment. Further information on this activity is given in the " Life Stories " unit in Part B, *Following On.*



Water Plants and Algae : The fish-tank is the obvious place for studying water plants and algae, but large jars are also quite useful. Common aquatic plants can be purchased from pet stores or fish-breeders and there are many others that can be obtained from a nearby pond or a creek.

Note.—Teachers should encourage children to take care in their collecting activities—care to avoid being bitten by whatever may bite, and care in their investigation of the banks of ponds and creeks. Learning responsible forms of behaviour is not the least among the kinds of learning that should come from a study of science.

HUMAN BEINGS

There is another collection of living material that is available for observation and comparison—the children themselves and their families. Comparisons that can be usefully made will be concerned with cases when children can investigate the ways in which living organisms, both plant and animal (including human beings), handle problems that they all face. A number of these problems are described in subsequent units.

At this stage, when children are busily engaged in caring for animals or plants and trying to provide the most favourable environment for them, it will be easy to arouse interest in the conditions human beings need to maintain themselves. Some topics that can be discussed and actively studied might arise from the following :—

1. The birth of white mice, kittens, pups, budgerigars and the subsequent care, or apparent lack of it, that the young receive may lead to a study of patterns of infant care in human communities—our own community, primitive communities, and communities in past times.
2. The planting of many seeds in a restricted area and the planting of fewer seeds in an area of similar size may lead to comparisons and discussions on the effects of crowding. A large number of caterpillars, daphnia, or aphids with a restricted food supply may lead to other comparisons, and these in turn could lead to a study of the growth of human populations and how they are linked with their food supply. The decay of civilization in the Tigris-Euphrates area is closely linked to the destruction of the irrigation system. The destruction of Carthage by the Romans was made final by the salting of fields and the destruction of other aspects of agriculture. Life in overcrowded slums and ghettoes is also destructive to human values as well as emotional and physical health.
3. Disease in pets or plants may also lead to a study of disease in humans.
4. Learning and communication among animals and humans may also be compared.
5. Comparisons of structures could also be undertaken.

Little more needs to be said at this stage, since these matters will be taken up again in subsequent units. For the present, it is sufficient to suggest that teachers should not disregard the human inhabitants of an enriched learning environment where life is under continuous study.

APPENDIX II

TIME

Introduction

Time is made meaningful only by noting changes occurring ; some changes occur over a longer period than others. The child's understanding of time follows a similar pattern to his other understandings. His early ideas are self-centred in that his observations of the passing of time are dominated by his personal experiences. In the pre-school stage he becomes aware of time to go to bed, time to get up, breakfast-time, playing time, TV time, and so on. This awareness continues to develop in his first year at school, so that he knows assembly time, playtime, and the various aspects of the day's routine. As his experience broadens, he uses other reference points and comes to learn that time exists in an objective sense and that similar observations of change can be made by others.

Another characteristic in the early stages is for the child, in making judgments, to be guided by a single, logical (to him) observation. He may say, for example, that because a tree is big it is older than a small tree, even if he is told that the smaller tree was planted first.

Activities

Numerous opportunities for developing children's awareness of time through happenings and changes occurring in time exist in many of the science experiences outlined in the various sections of this Guide. The teacher herself may see many other opportunities to bring in a time dimension. Some activities for this purpose are listed below. They are roughly in an order of development, the earlier ones being more suitable for the Beginners Grade. However, the activities of the older children should also include a continuation of those at the earlier level, the grade levels given being merely suggested.

Time is discussed with reference only to events occurring, and it is important that ideas of time should not become too firmly linked with the clock at too early a date in the child's life.

Much of the work involves development of language and other skills such as observation, measurement, and recording of dates, as well as being linked with applied number.

Links with Other Sections

This section is included in the Guide with " Interactions and Change ", for awareness of time comes from examination of change. For convenience, the time activities have been grouped. But, like other investigations in change, they could be grouped under headings of " Life ", " Matter ", or " Energy ". It is therefore best to link the activities here with others, and use the suggestions in this section to help develop an understanding of a time dimension when the children are engaged in the study of any other topic that involves change.

A Recognition of Regular Changes with Time

Discussion of the daily routine, such as bell time and morning and afternoon playtimes. Children may discuss and make interest books about the activities they carry out at the various times of the day, for example :

What happens in the morning ?

The sun comes up into the sky.
We have breakfast.
We clean our teeth.
Daddy brings me to school.
Sometimes it is frosty.
We sing songs and do equations.
We have our milk, etc.

What we do at playtime ?

We go to the toilet.
We wash our hands.
I eat my play lunch.
We play footy.
We watch the men with the bulldozer.

What happens at night-time ?

I take my fluoride tablets.
We sit by the fire.
Daddy comes home from work.
Mummy cooks the dinner.
I have a shower and go to bed.
Mummy tells me a story.
I watch " Whirly-birds ".
We see the moon and the stars.
It gets dark.

Observations of regular patterns can gradually be extended to include longer periods, such as the pattern of the days in the week, the names of the days, the school days, the week-end, and what is done on Saturdays and Sundays.

An introduction can be made to observations of the seasons.

Children in the infant school will gradually become aware that there are daily, weekly, monthly, and annual occurrences, and they may make charts or experience books of those they are involved in, for example :

Daily

We come to school every weekday.
The sun comes up and goes down every day.
We have breakfast, lunch, and dinner every day.

Weekly

We go to Sunday School each week.
Bank day is every Wednesday.
Religious Instruction is every Tuesday.

Monthly

We have our social service collection every month.
The Mothers' Club has a meeting every month.

Yearly

My birthday comes once a year.
Christmas time is once a year.
Each year we go into a new class.

There should be a gradual clarification of such time relationships as before, after, yesterday, today, tomorrow, last week, next week.

Discussions that lead to some understanding of the relative nature of these observations (for example, that today will be yesterday tomorrow ; that late for school is early for lunch) could take place occasionally as the children seem ready for the concept.

Using knowledge of the regular pattern to predict; for example, discussion of what happens after the bell rings for lunch.

Discussion and observation of daily changes such as the direction of the sun in the morning, at midday, and in the afternoon.

Grades I and II will find interest in observing changes in shadows. Sticks may be used or the children can mark or trace round other children's shadows in the morning and compare them with their shadows at lunch-time and in the afternoon.

Changes over a Short Time

Many of these activities involve experimental manipulated situations. In some cases it may be appropriate to measure the time taken in days, finding some way such as a stroke for recording each day. In shorter times children may find some informal way, for example, counting slowly or quickly, clapping a number of times, using an egg-timer, an hour-glass, or burning candles.

What can we do in a second?

Close the door.
Put hands on head.
Write capital I.

What can we do in a minute?

Write five words.
Read four sentences.
Walk across the room three times.

What can we do in an hour?

Have lunch and play.

Do our maths.

Read our books and draw two pictures.

Count all the children in the school.

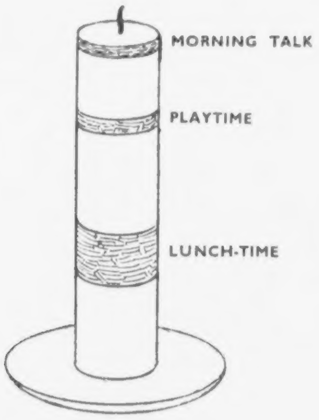
Questions asked during discussion can be used to assess the level of understanding, for example :

Would a seed come up in a minute ?

Can you run home in a second ?

Candle Experiments

If work is being undertaken with candles, children may speculate and experiment to discover how long it takes for a candle to burn away, and to compare candles of various sizes in this regard. They may try to predict whether a short thick candle will burn longer than a tall thin candle, and then observe what really happens. This may provide a link with work on conservation.



Children may trace the candle and then make a pictorial representation or a " candle graph " to show how long various activities took.

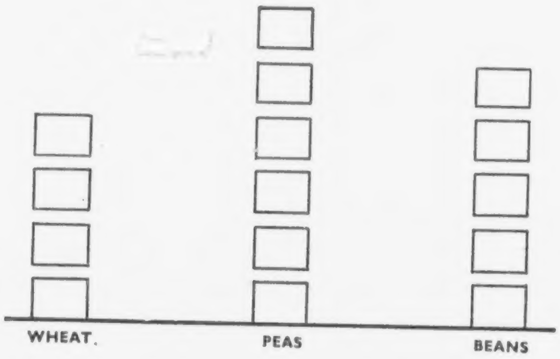
The divisibility of time intervals is a more difficult idea. If one type of candle is found to burn out more quickly than another, children can be encouraged to estimate how many of the rapidly burning candles will last as long as one candle of the longer burning type.

Egg-timer Experiment

The time taken for sand to run from two bottles (sand-clock arrangement) may be observed. Later, children may make predictions, that is, estimate which jar or bottle of sand will empty first. Children may try types of activities similar to those mentioned in the candle-burning experiment where they suggest what could take place, what they could do, or what they will be doing in the day's routine before the bottle is empty, and then test their suggestions.

Time for Seeds To Come Up

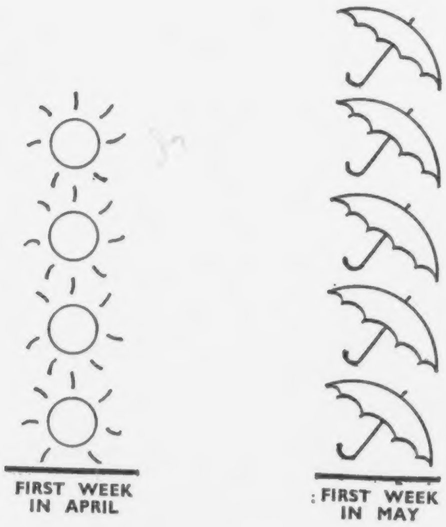
Seeds that germinate fairly quickly should be used, for example, wheat, radishes, peas, and beans. The children could keep a record of the number of days the various types of seeds take to germinate by putting strokes on a piece of paper or a chart, by putting one bead or counter in a tin for each day taken, or by pasting a square of paper on a chart for each day, as shown below.



Later, experiments with different starting points can be carried out. Children may plant one group of seeds two or three days after the first group, and compare the time it takes for them to come up.

Sky Changes

Children may enjoy watching how the sky changes. They may keep a daily pictorial record of the sky at a given time each day, and at the end of the week (or the month) count how many days the sky was blue, grey, cloudy, or white cloudy, as well as how many days were sunny, rainy, or windy. Simple graphs may be made to show these points, for example, the number of sunny days in each month. A token of some kind may be stuck on a chart for each sunny day or each wet day in the month.



In Grade II, observations may be made for temperature changes during the day, for example, at 9 a.m., 12 noon, and 3 p.m. Graphs, as mentioned above, may be compiled to show the temperature at a given time each day.

Time Taken To Bring About a Variety of Changes

Activities in this section could include finding out—

- how long it would take to melt a given solid or freeze a given liquid ;
- how long it would take to beat cream into butter ;
- how long it would take for a given liquid to evaporate ;
- how long it would take cloth to dry ;
- how long it would take sediment to settle ;
- how long it would take to blow up a balloon ;
- how long a candle would burn under a jar ;
- how long a wind-up toy would continue to work ;
- how long a top would continue to rotate ;
- how long a ball would go on bouncing ;
- how long a swing or a merry-go-round would continue to move without being pushed (with or without a load) ;
- how long it would take for a piece of paper, cardboard, or wood to burn.

Ways of measuring time might be by counting, clapping, or breathing, or by other activities done during the day.

Changes over Longer Periods

Growth Rate of Plants

Observing and measuring change in the height of a plant (such as a bulb) over several days or weeks. This could be recorded by making a bar graph of strips of paper used for measuring the height each day.

Changes in Colour of Grass

Observing how long it takes for grass covered with a brick or a piece of wood to turn yellow, and then observing how long it takes to become green again.

Growth of Young Animals

Changes in shape and size may be traced on paper ; the weight of a puppy, a kitten, a rabbit, and a duck could be measured.

Growth of Children

Children may keep streamer lengths (or tape or string lengths) of their own height. Weight records might also be kept.

Other Changes

Changes in a nearby shrub or a tree may be observed over the year. For example, the following cycle could be traced : Autumn leaves, bare, bud swelling, blossom, green leaves.

Changes in the shape of the moon over a month, pictorially recorded.

Changes in pieces of wood (for example, decay) could be recorded over a period of time.

The possible ages of trees in the locality, or the ages of pet animals or zoo animals could be compared with the ages of the children.

Historical Time

Only a beginning could be made in Grades I and II. Children might collect pictures and other information about things in the past, such as old cars, boats, aeroplanes, clothes, or pre-historic animals. These may be discussed, described, and compared with things in the present, and in the future (pictures of space ships, men on the moon). Children will enjoy discussing, drawing, and writing about these. Interest books may also be compiled.

Relationships in Time

Children may think about relationships between themselves and their parents or grand-parents, or between themselves and the next generation.

Pupils should recognize the differences as well as the similarities in time-cycles.

Children could discuss the pattern of the days, the seasons, and so on, with emphasis on the differences as well as the recurring similarities. For example :

> Breakfast times come round each day, but are they the same ? Are they different ?
>
> Is your birthday this year the same as it was last year ?
>
> Is this Monday the same as Monday last week ?
>
> Will spring next year be the same as spring last year ?

Speed and Distance

Compare the distance fast-moving and slow-moving clock-work toy cars will travel in the same time. Later, this could be tried with the cars loaded and compared with the distances travelled when the cars were unloaded.

Compare the time taken by toys to travel a given distance.

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